# BIOMEDICAL WASTES

# IN

# BRITISH COLUMBIA

## REPORT OF THE

## BRITISH COLUMBIA TASK FORCE ON

## BIOMEDICAL WASTE MANAGEMENT

MAY 1989

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# BIOMEDICAL WASTE STRATEGY URGED

A comprehensive system for the treatment and disposal of biomedical wastes is outlined in a report released today by Environment Minister Bruce Strachan.

"Dealing with the growing volumes of wastes of all kinds is one of the biggest environmental challenges we face in British Columbia," Strachan said.

"Cabinet has endorsed this report in principle, and we will work closely with municipal and regional governments to develop a biomedical waste management strategy based on its recommendations."

"I welcome the release of this report," said Health Minister Peter Dueck. "It provides a framework for hospitals and the provincial and regional governments to develop a comprehensive strategy for dealing with these wastes."

Prepared by a Ministry of Environment and Ministry of Health Task Force on Biomedical Waste Management, the report contains over 35 recommendations for improved management of biomedical wastes.

The strategy includes:

* development of regulations;

.../2

* amendments to the Waste Management Act to enable municipal or regional governments to participate in biomedical waste management;

* preparation of discharge, design, and operational criteria for biomedical waste incinerators;

* development of a planning process for biomedical waste facilities; and

* a commitment to improved education, training, and awareness on biomedical waste management.

Under amendments to the Waste Management Act, municipalities would be required to develop plans for dealing with biomedical wastes by the end of 1992.

According to the report, a survey of British Columbia hospitals and medical laboratories indicated that they generate approximately 16 tonnes of biomedical wastes daily.

The Task force, chaired by Ministry of Environment toxicologist Dr. John Ward, reviewed submissions from the medical, dental, and veterinary professions, hospitals, and the waste management industry.

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# Executive Summary

In response to serious concerns about the management of biomedical wastes in British Columbia, the Deputy Ministers of Environment and Health formed a Task Force on October 1, 1987 to investigate the situation and to recommend a broad biomedical waste system for the Province. This report describes the work of the British Columbia Task Force on Biomedical Waste Management. This summary follows the organization of the twelve major chapters of the report.

## Introduction

Recently there have been growing numbers of reports about problems with the management of biomedical wastes. Incidents in this Province such as human anatomical waste appearing in the municipal waste stream, waste management workers being sprayed with blood, and wildlife dying from eating carcasses contaminated with toxic drugs spurred the formation of the present Task Force.

Composed of members from the Ministries of Environment, Health, the Greater Vancouver Regional District, and the City of Vancouver, the Task Force was requested to 1) review the definition and classification of biomedical wastes, 2) develop a B.C. biomedical waste inventory, 3) review existing and available biomedical waste technologies, 4) evaluate the biomedical waste requirements of other jurisdictions, and 5) recommend a system for managing biomedical wastes in the Province. It was anticipated that the work of the Task Force would take about one year, and the due date for the final report, to be submitted to the Deputy Ministers of Health and Environment, was set at December 1, 1988.

## Biomedical Waste Definitions, Classification, Sources, Hazards and Impacts

After a review of biomedical waste definitions, classification schemes, and lists of biomedical waste sources from various agencies and jurisdictions, the Task Force adopted working definitions, biomedical waste categories, and sources upon which to base its work.

The biomedical waste categories include anatomical solid and liquid waste from humans and animals, microbiological wastes such as waste serums and vaccines, non-anatomical wastes such as equipment, waste sharp items such as hypodermic syringe needles, called "sharps", and chemical and pharmaceutical wastes. Sources such as hospitals, public health units, doctor's offices and clinics, laboratories, veterinary clinics, blood banks, and crematoria were addressed.

The Task Force devoted a substantial amount of time to the issue of the actual and potential impacts and hazards of biomedical wastes. It was concluded that while there is little evidence of significant adverse human health or environmental impacts from the typical handling of these wastes, adverse impacts can and do occur if the wastes are not handled properly.

Sharps can cause physical injury, infectious wastes can cause disease, and waste chemicals and pharmaceuticals various toxic impacts. Diseases such as AIDs and hepatitis B were frequently discussed. In addition to the physical impacts of biomedical wastes are psychological factors such as perception and attitude. The Task Force observed that the perception of risk associated with biomedical waste can vary remarkably, and often differs from the risk evaluated from a scientific or medical standpoint.

### Survey of Non-Governmental Stakeholder Activities and Needs

Input was sought from a host of biomedical waste stakeholders. Regional governments, medical laboratories, waste management companies, institutions such as hospitals and public health units, and professional organizations were some of the major stakeholders invited to provide information on their biomedical waste needs and activities. There was broad agreement that a system for managing biomedical waste was need in B.C. and that the proper management of waste sharps was a high priority. It was evident that more education, training, and information were needed by most biomedical waste stakeholders.

### Task Force Questionnaire Survey

In order to determine the nature, volumes, and types of biomedical wastes generated in British Columbia, the Task Force developed and distributed two questionnaires. One was used for hospitals, and the other was sent to veterinary clinics, family physicians, dentists, the Canadian Red Cross and university animal care facilities.

### Inventory of Biomedical Waste In B.C.

The Task Force determined that the generation rates for biomedical wastes in the Province are similar to those rates from other jurisdictions. It is estimated that hospitals in B.C produce a total of about 4 kilograms of waste per bed per day, that infectious waste comprises about 10% of that total, 0.4 kg/bed/day and that biomedical wastes are produced at a rate of about 0.5 kg/bed/day. Based on 20,296 hospital beds in the Province, and information from a direct hospital survey, it is estimated that a total volume of 16 tonnes of biomedical waste are produced daily in B.C. This compares with an estimate of 10 tonnes per day in B.C. based on a literature-based biomedical waste generation rate.

### Biomedical Waste Handling, Storage, Treatment and Disposal

This chapter reviews the biomedical waste technologies used in the Province, and then considers the technologies available. Major issues involve waste segregation, packaging, labelling, compaction, treatment and disposal to sanitary sewers or landfills and incineration. Currently much of the biomedical waste in the Province is burned in incinerators that are believed to be inadequate. Some biomedical wastes are now routinely disposed of in sanitary sewers and landfills in contravention of existing Provincial regulations and municipal by-laws.

### Legislative and Regulatory Biomedical Waste Controls

The Task Force carefully reviewed existing legislation on biomedical wastes. There appears to be no comprehensive legal system addressing the management of biomedical wastes from "cradle-to-grave" in North America. Nevertheless, attempts are being made Nationally to develop such a system, but it may be several years before it is ready for implementation. In the meantime, regulations for special wastes under the Provincial Waste Management Act apply now to infectious wastes, which are part of the biomedical waste stream.

### General Biomedical Guides

The eighth chapter in this report reviews a number of guides covering different aspects of biomedical waste management. The Canadian Standards Association standard "Handling of Waste Materials within Health Care Facilities" is particularly relevant. Other guides considered come from the United States Centres for Disease Control and Environmental Protection Agency, Hospital Accreditation Agencies, the Canadian Centre for AIDs, and the World Health Organization.

### Regulatory Agency Administrative Activities

The Task Force has briefly summarized the roles, responsibilities and activities of major government agencies addressing biomedical wastes in British Columbia. The agencies included are the B.C. Ministries of Environment and Health, the Greater Vancouver Regional District, and several Federal and National agencies.

### Summary of Reports on Biomedical Wastes

A number of major reports on biomedical wastes have appeared during the last few years, and the authors of several have had mandates similar to that of this Task Force. Thus it was regarded as essential that these reports be reviewed to assist in the identification of major issues and the clarification of contentious points. Chapter 10 contains a summary of nine of these reports.

### General Discussion

Chapter 11 summarizes the observations and needs from the previous ten chapters. In this Chapter the Task Force focusses intently on the issue of biomedical waste technologies and practices. The main needs identified are summarized below:

- a uniform definition for biomedical wastes
- guidelines for a wide range of biomedical waste issues
- a uniform system for administering, managing and communicating about biomedical wastes.
- cost-effective biomedical waste technology options
- education and training programs on biomedical wastes

# SUMMARY OF RECOMMENDATIONS

## DEFINITION AND CLASSIFICATION OF BIOMEDICAL WASTE

1. Until a National consensus on a definition is achieved, it is recommended that a biomedical waste definition for interim use in British Columbia be adopted by the Province. The Task Force recommends that the detailed definitions in Appendix 12.1 be used, which include specific terms and waste categories.

2. It is recommended that continued support be given to the Canadian Council of Resource and Environment Ministers (CCREM) and Transport Canada in their efforts to develop a National definition for biomedical wastes.

3. It is recommended that agencies and organizations that develop standards and guidelines for biomedical waste management be encouraged to develop definitions for biomedical waste that are consistent with those developed Nationally. It is also recommended that city, municipal and regional government authorities be encouraged to amend bylaw definitions pertaining to biomedical wastes to achieve consistency with Provincial definitions adopted or developed.

## HAZARDS AND IMPACTS OF BIOMEDICAL WASTE

4. Until National initiatives are complete, it is recommended that the special biomedical wastes[1] and chemical and pharmaceutical wastes defined by the Task Force be considered as those biomedical wastes requiring special handling, treatment and disposal in British Columbia.

5. It is recommended that the Province and other government agencies monitor research into the physical hazards of biomedical wastes and their fate and impacts when disposed of and/or treated.

## NON-GOVERNMENTAL STAKEHOLDER ACTIVITIES

6. It is recommended that governments in B.C. take initiatives to ensure that adequate biomedical waste management facilities are developed in the Province.

7. It is recommended that governments in B.C. develop and implement legislative, regulatory and administrative programs to control biomedical wastes.

8. It is recommended that contingency plans providing alternative disposal methods for biomedical waste be developed by waste generators.

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[1] Means the types and sources of biomedical wastes that should be handled, treated, and disposed of in a special manner.

## BIOMEDICAL WASTE INVENTORY ISSUES

9. If "universal precautions[2]" are adopted for biomedical wastes, it is recommended that further inventory work be carried out to provide data for the sizing of potential biomedical waste management facilities. The B.C. Ministries of Health and Environment should consult closely on this issue should it develop further.

## BIOMEDICAL WASTE MANAGEMENT TECHNOLOGIES AND PRACTICES

### Segregation, Packaging and Labelling

10. It is recommended that the Province adopt the Canadian Standards Association methodology with minor modifications, for the segregation, labelling and packaging of biomedical wastes.

11. It is recommended that the compaction of packaged solid biomedical wastes destined for off-site treatment or disposal be discouraged or prohibited.

### Off-site Transportation

12. Insofar as they apply to off-site transportation, it is recommended that the Province continue its present controls of biomedical wastes as special wastes through the Special Waste Regulation.

### Use of Transfer Stations and Staging Areas

13. Concerning their suitability for biomedical wastes, it is recommended that waste transfer stations and/or collection depots be used only as collection or staging areas. Biomedical waste should not be compacted at these facilities, in order to preserve the integrity of packaging.

14. Should biomedical wastes be properly segregated, packaged, and labelled, and handled at transfer stations, to help avoid misperception of the risks of managing biomedical wastes, it is recommended that consideration be given to dedicating specific transfer station areas, and perhaps times, for transferring biomedical wastes. Adequate training of transfer station staff should be provided and consideration given to needs for contingency plans, government permits, and special equipment.

15. In the event that biomedical wastes are not properly segregated from the normal refuse stream, it is recommended that the use of transfer stations for biomedical wastes before final disposal be stopped. These wastes should be taken directly to a disposal facility from source, until adequate segregation is achieved or alternate arrangements to handle biomedical wastes at the transfer station are arranged.

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[2] "universal precautions" means the policy where all human blood, blood products and body fluids are considered infectious.

## Central Disposal Facilities

16. It is recommended that as appropriate, feasibility studies, providing an indepth analysis of the options, costs, availability, and acceptability of centralized biomedical waste treatment, collection, and disposal facilities be carried out for high population areas of the Province. The allocation of responsibility for this project between the Province, regional governments, and the private sector should be determined.

## Incineration

17. It is recommended that an ad hoc working group be struck to develop criteria for discharges, design, and operation of biomedical waste incinerators in British Columbia.

18. It is recommended that the costs of upgrading existing biomedical waste incinerators to meet any new National or Provincial discharge guidelines be determined.

19. It is recommended that the potential of existing or planned incinerators in the Province to dispose of biomedical wastes be studied.

20. It is recommended that the incineration of all categories of biomedical wastes identified by the Task Force be regarded as acceptable, with the proviso that pure liquid biomedical wastes are not burned and that the incinerators are capable of and operated so they properly destroy each waste type.

## Sanitary Landfill Disposal

21. It is recommended that the sanitary landfill disposal of 1) special biomedical waste that has not been pretreated and 2) waste chemicals and pharmaceuticals be considered unacceptable. Sanitary landfill disposal of solid special biomedical waste that has been sterilized or disinfected should be considered acceptable, provided that sharps have been: 1) blunted or ground and then pretreated or 2) solidified; and that human anatomical waste is excluded. The remaining solid infectious wastes which do not include special biomedical wastes, should not require pretreatment before sanitary landfill disposal.

22. It is recommended that all biomedical wastes that are disposed of in a sanitary landfill, irrespective of their pretreatment status, be covered immediately following disposal.

## Sanitary Sewer Disposal

23. It is recommended that certain biomedical wastes may be disposed of in sanitary sewer systems. All liquid infectious biomedical wastes may be discharged to sanitary sewers without pretreatment, with the exception of liquid special biomedical wastes. The remaining infectious liquid wastes, which do not include liquid special biomedical wastes generally, may be discharged to sanitary sewer without pretreatment. Waste chemicals and pharmaceuticals generally should not be discharged to sanitary sewer.

## Disposal of Specific Biomedical Waste Categories

### Contaminated Solid Animal Anatomical Waste

24. It is recommended that a review be carried out on the practices of using solid animal anatomical waste contaminated with pharmaceuticals or infectious organisms for animal feed, fertilizer or in rendering plants.

### Waste Sharps

25. It is recommended that a specific management strategy for waste sharps that is accessible to various types of generators, from individual doctors and sharps generators, to large institutions, be devised and implemented. This strategy may involve various collection, storage, treatment, and disposal options.

26. Before disposal to a sanitary landfill, It is recommended that waste sharps be immobilized by solidification or destroyed by incineration, or grinding and disinfection.

### Chemical and Pharmaceutical Waste

27. It is recommended that disposal guidelines for small quantities of pharmaceuticals and chemicals from biomedical wastes generators be developed.

28. It is recommended that the Waste Management Act's Special Waste Regulation continue to apply to waste pharmaceuticals and chemicals.

29. It is recommended that specific systems to handle waste pharmaceuticals from patients, doctors, pharmacies, and clinics be developed. Collection, return, and disposal methods should be considered. Return of waste pharmaceuticals and recycling of chemicals should be encouraged.

### Blood, Blood Products and Other Bodily Fluids

30. It is recommended that the disposal of small quantities of non-infectious blood, blood products and other bodily fluids to sanitary sewer systems be legally permitted. Sanitary sewer disposal of specified infectious blood and blood products, should be permitted after disinfection or sterilization.

### Infectious Non-Anatomical Wastes

31. As long as they do not qualify as special biomedical wastes, it is recommended that non-anatomical wastes may be disposed of without pretreatment.

### Recombinant DNA and Biotechnology Wastes

32. It is recommended that the Province should encourage National and International initiatives to develop controls for wastes from recombinant DNA and biotechnology activities, and keep abreast of developments in this field.

## LEGISLATIVE AND REGULATORY PROGRAMS AND GUIDELINES

33. It is recommended that continued support be given to the Canadian Council of Resource and Environment Ministers (CCREM) in its development of national guidelines for on- and off-site biomedical waste management practices.

34. General controls for a variety of biomedical waste practices are required now in British Columbia. It is recommended that one of the following four general methods be adopted:

Method 1:

The Province should develop and implement Provincial guidelines for biomedical wastes independent of ongoing efforts to develop National biomedical waste guidelines. The Canadian Standards Association Standard "Handling of Waste Materials within Health Care Facilities" should be adopted as Provincial policy, supplemented with specific modifications to address issues requiring additional attention, for example:

1. Improve the classification and controls for blood, blood products and body fluid wastes.
2. Supplement with detailed guidance for off-site biomedical waste management.
3. Provide a means of identifying biomedical wastes that have been rendered non-infectious through sterilization or disinfection.
4. Provide alternate colour coding to that presented for filled sharps containers and pharmaceutical wastes.
5. Qualify references to preferred waste management options.
6. Provide guidance for the management of biomedical wastes from biotechnology and recombinant DNA work.

Method 2:

In the period when National guidelines for biomedical waste practices are being developed, the Province should develop and implement Provincial guidelines for biomedical wastes, as described in Method 1. In the event that compliance with the Provincial guidelines were poor the Province should frame them in regulatory form.

Method 3:

During the period of development of National guidelines for biomedical waste management, the Province should develop and implement its own guidelines for biomedical wastes, as described in Method 1. When National biomedical waste guidelines become available, the national guidelines would replace those developed previously by the Province.

Method 4:

The Province, through the Ministries of Health and Environment, should immediately develop and implement legislative and regulatory controls for biomedical waste management in British Columbia, based on the controls described in Method 1. Consideration should be given to adopting National guidelines or amending Provincial ones when the former become available.

In view of strong evidence of the failure of the present system for managing biomedical wastes, despite efforts of regulatory agencies, the Task Force favours Method 4.

## REGULATORY AGENCY ADMINISTRATION

35. It is recommended that resources to administer biomedical waste control programs be supplied by regulatory agencies as the long-term biomedical waste strategies are developed and implemented.

36. It is recommended that powers to certify crematoria under the Provincial Cremation Act be transferred to the Ministry of Environment.

## COMMUNICATIONS, INFORMATION AND TRAINING

37. It is recommended that information and educational materials and programs on the hazards and controls for biomedical wastes be prepared, and made available to the appropriate audiences.

# 1.0 INTRODUCTION

This report describes work carried out by the British Columbia Task Force on Biomedical Waste Management (hereafter referred to as the "Task Force"). The Task Force has reviewed the biomedical waste situation in British Columbia and elsewhere, and is recommending a broad biomedical waste management system for the Province.

In this Chapter, the background leading up to the Task Force's formation is discussed, and its Terms of Reference and membership reviewed. Subsequent chapters address the following biomedical waste topics:

- Definition, classification, sources, hazards and impacts
- Non-governmental stakeholder activities and needs
- B.C. biomedical waste inventory
- Biomedical waste management technologies
- Legislative and regulatory programs
- Guidelines for biomedical wastes
- Regulatory agency administrative activities
- Major reports on biomedical waste management
- Possible control strategies
- Recommendations

Since this topic involves medical, scientific, and technological issues, readers unacquainted with these fields may wish to consult the glossary in Appendix 1.1 for the definition of unfamiliar terms.

## 1.1 BACKGROUND TO THE ESTABLISHMENT OF THE TASK FORCE

### 1.1.1 Biomedical Waste Problems

Throughout North America and Europe, problems involving the management of biomedical wastes have recently been observed by the public, waste management workers, biomedical waste generators and other stakeholders. Sensational headlines have appeared in the printed media and have focussed attention on the situation, for example:

> "Police Burn Car Smeared in AIDs Blood"
>
> "Thirty Miles of New Jersey Beach Closed After Assault by Infectious Wastes"
>
> "Twelve Children Find and Play with Vials of AIDs infected Blood from Open Trash Bin"

The message in these headlines is that there are serious risks associated with these wastes, and that they are not always being properly managed.

While none of these incidents occurred in British Columbia, this Province has recently had its own biomedical waste problems. Reports of human anatomical waste in the municipal refuse stream; waste management workers being sprayed by blood from contaminated blood bags; unacceptable and unpleasant emissions from hospital incinerators; threats to public health and the environment from university research with virulent organisms; and the death of wildlife from scavenging pharmaceutical-contaminated animal carcasses have all occurred within the last two years.

In response, many government agencies and stakeholder organizations are now implementing biomedical waste control strategies. The development of these strategies, however, has not been straightforward or simple because of the a number of important factors that relate to the management of biomedical wastes. There can be disagreement over which factors are most important, and what should be done about them. For example, there is controversy concerning the hazards and impacts of biomedical wastes. Little research is available on the fate and impacts of biomedical wastes after disposal. Further, the risks posed by biomedical wastes are perceived very differently by biomedical waste stakeholders.

Some major factors bearing on the biomedical waste issue are:

- Medical and toxicological impacts
- Perceptual differences
- Economic costs
- Engineering and technological capabilities and needs
- Legislative requirements
- Administrative and institutional needs
- Geographic limitations
- Available biomedical waste volumes

In view of the wide range of factors that are often considered in developing biomedical waste management strategies, it is not surprising that the systems developed in different jurisdictions vary considerably. Figure 1.1 illustrates the interrelationship of various elements of a general biomedical waste management system.

### 1.1.2 Critical Biomedical Waste Situation in British Columbia

In the early 1980's biomedical waste generators and regulatory authorities gradually became increasingly aware of the need for specific attention to biomedical waste management in B.C. However, in late 1986 the the need for immediate action became apparent with reports of problems associated with the disposal of biomedical wastes originating from Lions Gate Hospital in North Vancouver.

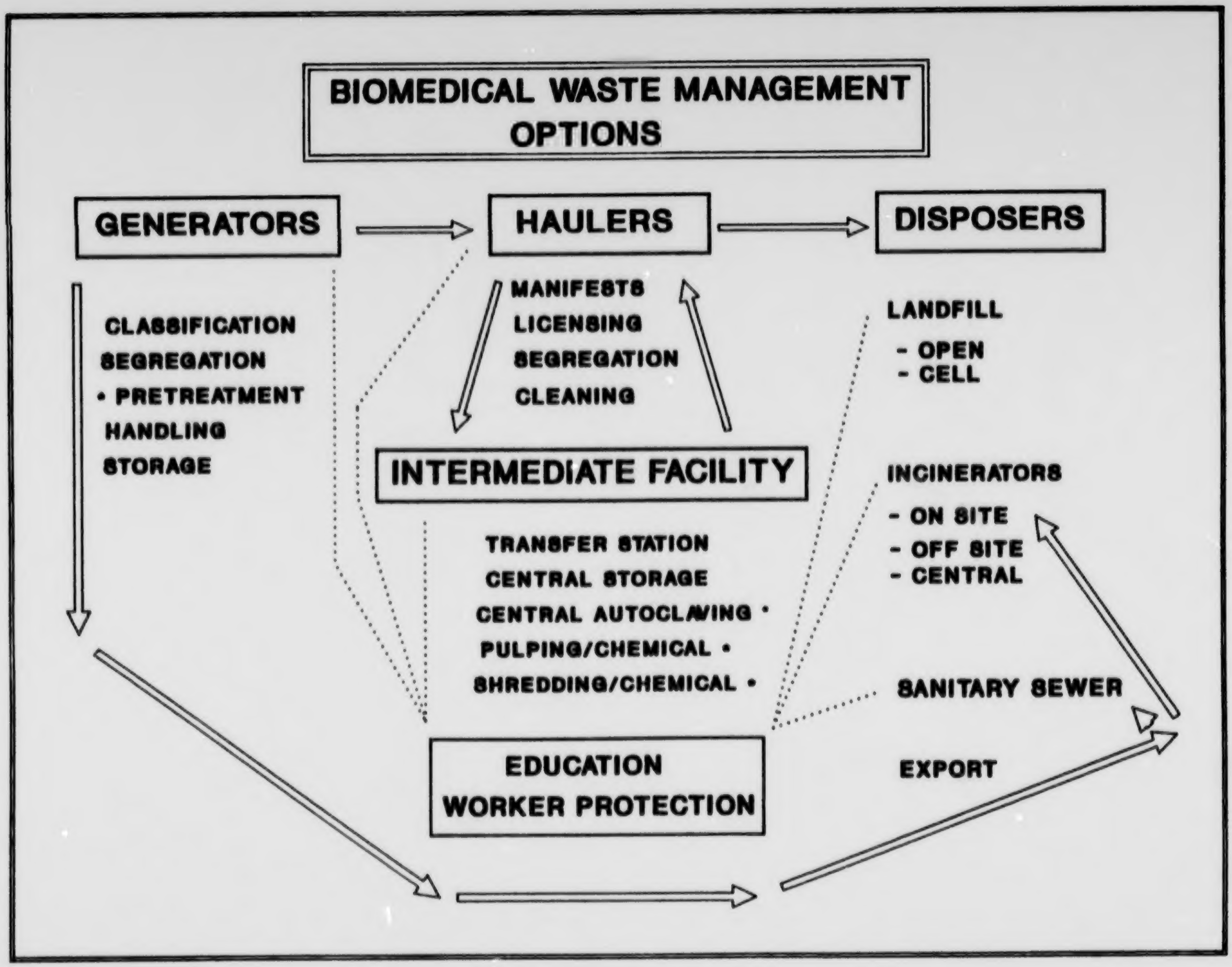
Complaints had been received from GSX Waste Technology Services Ltd. at the North Vancouver Solid Waste Transfer station that workers had been exposed to biomedical wastes such as blood bags, dressings, intact needles, and human wastes, and that the workers were refusing to handle this type of waste. In response, the Greater Vancouver Regional District convened a meeting of about 25 stakeholders in late December that year, to discuss the situation at the Transfer station, to review applicable standards and regulations, and to discuss possible short- and long-term solutions.

## 1.2 FORMATION OF THE B.C. TASK FORCE ON BIOMEDICAL WASTE MANAGEMENT

The possibility of a Task Force composed of concerned parties to develop systems for biomedical waste disposal was first discussed at this meeting. Shortly afterwards, senior staff from the Ministries of Health and Environment met to review the situation and to consider control options. It was decided that an interministerial task force would be an appropriate vehicle to develop recommendations for long-term solutions.

FIGURE 1.1

BIOMEDICAL WASTE MANAGEMENT OPTIONS


BIOMEDICAL WASTE MANAGEMENT OPTIONS
GENERATORS
CLASSIFICATION
SEGREGATION
• PRETREATMENT
HANDLING
STORAGE
HAULERS
MANIFESTS
LICENSING
SEGREGATION
CLEANING
DISPOSERS
LANDFILL
- OPEN
- CELL
INCINERATORS
- ON SITE
- OFF SITE
- CENTRAL
SANITARY SEWER
EXPORT
INTERMEDIATE FACILITY
TRANSFER STATION
CENTRAL STORAGE
CENTRAL AUTOCLAVING •
PULPING/CHEMICAL •
SHREDDING/CHEMICAL •
EDUCATION
WORKER PROTECTION

## 1.3 TASK FORCE TERMS OF REFERENCE, ACCOUNTABILITY AND MEMBERSHIP

The mandate of the Task Force was embodied in five Terms of Reference which are contained in Appendix 1.2. Reporting to the Deputy Ministers of Environment and Health, the Task Force was asked to make general recommendations on actions and policies required to ensure that biomedical wastes are handled safely and acceptably across the Province, through:

1 ) review of the definition and classification for biomedical wastes,

2 ) development of a B.C. biomedical waste inventory,

3 ) review of existing and available biomedical waste management technologies,

4 ) evaluation of biomedical waste requirements of other jurisdictions, and

5 ) recommendation of a biomedical waste management system for B.C.

While all the sources for biomedical wastes were not specified, examples of sources such as medical offices, hospitals and mortuaries were mentioned. It was anticipated that the work of the Task Force would take about one year, and the due date of the report was eventually set at December 1, 1988.

The Task Force Membership is shown in Appendix 1.3. Chaired by the Ministry of Environment, Task Force members were also appointed from the Ministry of Health, the Greater Vancouver Regional District, and the City of Vancouver. While eight of the Task Force members were formally chosen, a number of individuals made major contributions, and these are also shown in Appendix 1.3.

## 1.4 GUIDANCE TO THE TASK FORCE

During the course of the Task Force's work, a number of local issues arose. For example, individual hospitals indicated a desire to upgrade their biomedical waste incinerators, and certain waste generators were having difficulty in keeping biomedical wastes out of the municipal solid waste stream. The possibility of broadening the mandate of the Task Force to address certain site-specific biomedical waste problems was discussed, and the Task Force sought advice from time to time from Senior staff from the Ministry of Environment on the general direction that should be taken. The advice received, and consistently conveyed to persons dealing with these site specific problems, was that the mandate of the Task Force would remain Provincial in scope, and that it would be best to wait until the final report of the Task Force had been submitted and reviewed by the Ministries of Environment and Health, before embarking on a new, site-specific courses of action.

## 1.5 GENERAL TASK FORCE ACTIVITIES AND INFORMATION SOURCES

At the outset of its work, the Task Force decided that direct experience of the biomedical waste situation in British Columbia was important. Accordingly, the Task Force visited a number of facilities where these wastes were handled, disposed of or generated. This included tours of one small and one large hospital, a waste transfer station, a large municipal solid waste incinerator and a public health unit. In addition, the Task Force closely followed several biomedical waste issues that were current, including the proposed Francisella tularensis experiments at the University of Victoria, and the operation of the Thermal Reduction Inc. incinerator used for biomedical wastes in Bellingham, Washington.

In addition, the Task Force felt that direct contact with biomedical waste stakeholders from a wide range of backgrounds in B.C. would be desirable. As discussed in detail in Chapter 3.0, a large number of stakeholders were invited to attend meetings with the Task Force to describe their needs. Stakeholder representatives from hospitals, waste management companies, regional governments, and others were provided an opportunity to meet with the Task Force, or to submit their comments in writing, if they did not wish to meet directly. Many contacts were made with companies offering biomedical waste management services.

A major portion of the information the Task Force used came from the open literature such as scientific, technical and medical journals as well as government and stakeholder reports, guidelines, and legislation. These sources are cited in the references to each Chapter of this report.

Individual members agreed to be responsible for various projects that the Task Force developed, which form the basis for the Chapters in this report. Overall project coordination and editing of the final report was taken on by the Chairman, and secretarial assistance mainly provided by the Ministry of Environment.

# 2.0 BIOMEDICAL WASTE DEFINITIONS, CLASSIFICATION, SOURCES, HAZARDS AND IMPACTS

## 2.1 REVIEW OF DEFINITIONS FROM OTHER JURISDICTIONS

Of the approximately 30 jurisdictions in North America from which draft or enacted legislation on biomedical wastes was received, the following typifies the definitions in use, the categories identified, and the generating sources controlled.

### 2.1.1 Ontario

Definition

"Biomedical waste" is pathological and infectious.

- pathological is defined to be all human anatomical and those animal anatomical suspected of being infected with a disease communicable to humans or animals.
- infectious is defined as contaminated or suspected to be contaminated with the causative agents of infectious disease or their toxic products and capable of infecting or causing disease in susceptible individuals or animals exposed to them.

Infectious wastes do not merely contain pathogens but should be capable of transmitting infection.

Categories

- Human anatomical,
- Animal anatomical, infectious,
- Non-anatomical, infectious,
- Microbiological, infectious,
- Blood, blood products, and body fluids,
- Isolation wastes.

Other wastes requiring proper disposal:

- Hospital and health care wastes, non-infectious;
- Non-anatomical, decontaminated in approved device;
- Sharps.

Radioactive, chemical, chemotherapy and organic (solvent) wastes are not included in the Guidelines.

Sources

- Health care facilities,
- Doctors' offices,
- Diagnostic and research laboratories,
- Mortuaries.

(Ontario, 1985; Manual, 1986)

### 2.1.2 U.S. Environmental Protection Agency

Definition

- Isolation wastes,
- Cultures and stocks of infectious agents and associated biologicals,
- Human blood and blood products,
- Pathological - surgery and autopsy parts and fluids,
- Contaminated sharps (all sharps from patient care),
- Contaminated animal parts and bedding.

Other wastes not categorized but deserving individual evaluation are:

- contaminated equipment;
- all surgery and autopsy equipment;
- dialysis equipment;
- elected laboratory equipment.

Sources

- Hospitals,
- Medical laboratories,
- Research laboratories,
- Commercial diagnostic laboratories,
- Animal experimentation units,
- Industrial plants and labs,
- Others, such as biotechnology companies.

(U.S. Environmental Protection Agency, 1986)

### 2.1.3 Canadian Standards Association

| Categories | Sub-categories |
|---|---|
| • Human/animal anatomical waste | - Human anatomical<br>- Infectious animal anatomical<br>- Noninfectious animal anatomical |
| • Infectious nonanatomical waste | |
| • Sharps and similar waste | |
| • Chemical/pharmaceutical waste | - chemical waste<br>- pharmaceutical waste excluding cytotoxic pharmaceutical waste<br>- cytotoxic pharmaceutical waste |
| • Radioactive waste | |
| • Pressurized container waste | |
| • General waste | - office waste<br>- kitchen waste<br>- nonclinical waste<br>- noninfectious nonanatomical waste |

Sources

Health care facilities, excluding veterinary facilities and animal care centres.

(Canadian Standards Association, 1988)

### 2.1.4 U.S. Centers for Disease Control

Definition

Infective waste is not specifically defined, but the guideline is directed at wastes which represent a sufficient potential risk of causing infection during handling and disposal and for which special precautions appear prudent.

Categories

- Microbiology,
- Laboratory,
- Pathology,
- Blood, blood products, and body fluids,
- Sharps,
- Isolation.

Sources

- Hospitals

(Centers for Disease Control, 1980)

### 2.1.5 Other Definitions

Several other approaches to defining biomedical wastes are illustrated in the following examples:

- Canadian Transportation of Dangerous Goods Regulation (Canada, 1980): Infectious substances contain viable micro-organisms or their toxins that are known or suspected to cause disease in animals or humans;

- Michigan (Michigan, 1985): Infectious wastes contain varying amounts of micro-organisms and have a potential for causing serious illness depending on the type of micro-organism, its concentration, transmission route, and susceptibility of the persons at risk. Infectious wastes from patient care facilities (with eight primary microbial exceptions) are not considered hazardous. Microbial wastes from laboratories are hazardous (eg: culture stocks, body fluids, specimens, and equipment) and are considered in four levels of biosafety hazard.

- Virginia (Virginia, 1987) presents a definition of infectious and solid waste, lists categories of wastes included for special handling, categories of infectious wastes excluded, and categories of solid wastes exempted;

- West Virginia (West Virginia, 1985) is an example of a jurisdiction concerned only with controlling diseases communicable to humans, not animals;

- Hawaii (Hawaii, 1977) lists by name the diseases considered to be infectious and communicable;
- Florida (Florida, 1985) and Massachusetts (Massachusetts, 1987) relate some requirements on basis of infectious wastes being solid or liquid;
- Massachusetts' definition is in terms of "increased mortality or serious irreversible or incapacitating reversible illness, or posing substantial present or potential hazard to human health or the environment;"

## 2.2 WORKING BIOMEDICAL WASTE DEFINITION FOR TASK FORCE

On the basis of this review and to establish a rational approach in identifying the waste components of concern, the Task Force decided that three basic working definitions were required, as follows; and as shown in Appendix 2.1.

### Working Definitions

Biomedical wastes means those discarded materials which, due to their nature and generating source, categorized in Section 2.3, require specific treatment prior to disposal.

Biological wastes means solid and liquid wastes from human metabolic functions including feces, urine, vomitus, dialysis by-products, and the like.

Infectious means being contaminated or suspected of being contaminated with the causative agents, or their toxic products, of a communicable disease, and capable of transmitting such disease to susceptible individuals or animals.

The adoption of "biomedical" as the umbrella term is considered the most descriptive of the broad range of wastes to be encompassed and avoided the apparently contradictory or superfluous use of "pathological", "anatomical", or "infectious" as used in many jurisdictions as the primary references.

The separate identification of "biological" wastes is necessary to avoid confusion with anatomical components of the waste stream and is worded to be consistent with the further breakdown of the wastes into liquids and solids.

"Infectious" is defined to account not only for the presence of organisms which can cause a communicable disease, but also the capability of transmission to humans and animals.

## 2.3 BIOMEDICAL WASTE CLASSIFICATION

The purpose of categorizing biomedical waste streams is to group the wastes of potential concern so that they can be practically segregated. Further, the groupings should anticipate the availability of suitable treatment and disposal practices common to the waste components within each category. It is intended that where waste streams are not segregated following the recommended categories, the handling requirements for the entire biomedical waste stream would be dictated by the most stringent conditions established for any specific component. These working biomedical waste categories were determined from review of the documents listed in the References for this Chapter.

Working Biomedical Waste Categories

1. Solid human anatomical wastes, including any body part or tissue except extracted teeth, hair, nail clippings, and the like, but excluding biological wastes.

2. Liquid human anatomical wastes such as blood products, secretions, and similar body fluids, but excluding biological wastes.

3. Infectious animal solid and liquid wastes, including carcasses, body parts, body fluids, bedding materials, and associated biological wastes.

4. Infectious biological wastes.

5. Infectious non-anatomical wastes directly associated with patient care such as bandages, gowns, masks, gloves, tubing, and like equipment.

6. Waste sharps including hypodermic needles, syringes, scalpel blades, pasteur pipettes, and broken glass.

7. Infectious microbiological wastes including serums, vaccines, cultures, and stock used in clinical, research and industrial applications, and their associated fomites.

8. Chemical and pharmaceutical wastes including antineoplastics and associated fomites.

Note: Radioactive wastes are controlled by the Atomic Energy Control Board and B.C. Ministry of Health and were excluded from consideration by the Task Force.

## 2.4 SOURCES OF BIOMEDICAL WASTES

In order for the Task Force to carry out inventory work, and to identify biomedical waste generators, it was necessary to develop a list of biomedical waste sources. While a large proportion of the total provincial volume of biomedical waste probably comes from hospitals, the Task Force also identified a number of other potentially important non-domestic sources. A working list of biomedical waste generating sources is shown below:

Non-domestic Biomedical Waste Generating Sources

Hospitals
Public health units
Doctors' clinics
Dentists, orthodontists, periodontists, oral surgeons
Clinical, research, and teaching laboratories
Veterinary and other animal care facilities
Mortuaries and funeral homes
Coroner's offices
Pharmaceutical suppliers
Crematoria
Blood banks

The Task Force also recognized that because many individuals with infectious diseases live at home, domestic would also be important sources of biomedical wastes.

## 2.5 PHYSICAL HAZARDS AND IMPACTS OF BIOMEDICAL WASTES

The Task Force has concluded that there are three major classes of potential physical impacts associated with biomedical wastes: infection, which includes communicable diseases such as AIDs and Hepatitis B; chemical impacts, including acute toxicity, cancer, bioaccumulation of chemicals, and corrosion; and physical injury, particularly from waste sharps such as hypodermic syringe needles. These impacts arise because of the intrinsic properties of the impacting agent, the ease of transmission or exposure, and the presence of susceptible receptors or individuals.

### 2.5.1 Routes of Exposure

A variety of media are capable of being contaminated by biomedical wastes. For example, soil, water and air can be contaminated from improper waste disposal, while surfaces and food could be contaminated from inadequate waste handling within facilities generating biomedical wastes. Individuals can be exposed to these contaminants by direct injection, from injury by contaminated sharps; by inhalation of aerosols and vapours; through skin absorption of chemicals and pathogens; and through ingestion of wastes and contaminated materials.

### 2.5.2 Potential Receptors

The potential receptors, those which are potentially impacted by improper biomedical waste management, broadly include humans and the environment. However, consideration of specific receptors, such as patients, institutional workers, wastes management workers, and the public near biomedical waste management areas, suggests that not all human receptors will be impacted in the same manner. Similarly, environmental receptors include scavengers, which for example are common in landfills, that can act as vectors for disease transmission in wildlife. Indirect exposure could be widespread from emissions and leachate.

### 2.5.3 Potential and Actual Impacts

In the view of the American Centres for Disease Control and the Canadian Laboratory Centre for Disease Control, the greatest potential for infection from wastes in a hospital setting comes from:

1 ) microbiology laboratory waste,
2 ) human anatomical waste removed during surgery and autopsy
3 ) blood and blood products.

In hospitals, category 1 waste is usually sterilized before disposal to landfill, while category 2 waste is incinerated. Such measures are a likely reason why human disease is not usually observed in association with these wastes.

To investigate the impacts of biomedical wastes further, the Task Force requested Dr. John Farley, the Ministry of Health's infectious diseases epidemiologist to locate literature on the subject (Farley, 1988). Dr. Farley requested the Laboratory Centres or Diseases Control in Ottawa to carry out this search; however, no evidence on the subject was located. Dr. Farley has suggested that studies to determine the impact of biomedical wastes once they have reached their ultimate disposal site have probably not been carried out. This is consistent with the findings of the State Grand Jury Concerning the Treatment and Disposal of Hospital and Infectious Wastes in the State of New Jersey (New Jersey, 1988), that indicated that "no extensive, scientifically valid study has ever been done concerning health risks of waste handling."

In view of this evidence, statements by the American Centers for Disease Control that "there is no epidemiologic evidence to suggest that most hospital waste is any more infective than residential waste" and that "there is no epidemiologic evidence that hospital waste has caused any disease in the community as a result of improper disposal" (Centers for Disease Control, 1987) are understandable because the epidemiologic studies may not have been have carried out.

Similarly, Rutala (Rutala, 1988) has indicated that there is no microbiologic evidence showing that hospital waste is any more infective than residential waste. He cites one paper that suggests hospital waste microbial loads are 10-10,000 times less than household wastes. However, others (New Jersey, 1988) suggest the health risks of biomedical wastes extend over the entire waste life cycle from generation to ultimate disposal, because pathogens can remain viable in biomedical wastes for long periods.

Direct evidence on the impacts of handling biomedical waste is available. Infections in waste handlers are rare, and when they do occur, usually come from an injury such as a needle prick, where a pathogen is directly introduced into the body (Canadian Standards Association, 1988).

The impacts of several biomedical waste management practices are not clear. For example, apart from impacts on scavengers, information on the impacts of landfilling infectious wastes on leachate and air quality were not obtained. Furthermore, the impacts of untreated small quantities of infectious wastes from doctors offices and clinics, for example, in normal municipal refuse streams, has apparently not been investigated.

### Chemical impacts

The potential risks of chemical wastes are well known, and will not be described further here. Their problems include complaints of corrosion of automobile paint and unacceptable emissions from hospital incinerators, including toxic contaminants. Information on the impacts of waste discharges of chemicals such as sterilizing agents, anaesthetic gases and pharmaceuticals was not received.

### Injury

The most common type of problem associated with biomedical wastes that has come to the attention of the Task Force is injury from contact with sharps, whether they proved to be infective or not (Canadian Standards Association, 1988). These injuries; however, usually occurred from waste handling accidents within health care facilities, and not at disposal sites (Peck, 1988).

## 2.6 PSYCHOLOGICAL IMPACTS

The hazards associated with biomedical waste management are also recognized to be intimately associated with psychological factors such as perception and attitudes. The Task Force views these factors as being common to all levels of the issue; however, they can vary markedly from public, to occupational, to management settings.

For example, the potential hazard of a particular biomedical waste, such as blood contaminated tubing, has been ranked high by workers exposed to that waste, but low by health care professionals. In many instances perceptions and attitudes have often dictated the choices of management options made by policy makers. In the case of AIDs, for example, the increasing introduction of "universal precautions" illustrates the power of these factors.

## 2.7 DISCUSSION

It is apparent that biomedical waste management is commanding widespread study by regulatory agencies. Considerable variations, however, have arisen in the selection of appropriate definitions. The standardization of waste descriptions is most critical when different parts of the biomedical waste management system are required to mesh consistently. For example, the handling of wastes within an institution will only be efficient when disposal requirements are also considered, and made compatible. A comparison among the categories identified by the jurisdictions cited earlier in this chapter and the Task Force's working categories demonstrates the non-uniformity in approaches. Uniform definitions for biomedical wastes are obviously required.

The situation regarding the absence of information on impacts of biomedical wastes is also important. In view of the potential for adverse impacts to occur from the mishandling of biomedical wastes, continued surveillance of the literature and other impact reporting systems to determine the true extent of the problem may be necessary. It may be that epidemiologic evidence would be very difficult to obtain, and efforts need to focus on accident reports, clinical reports, workers' compensation claims, and other sources where single events are recorded.

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# 3.0 SURVEY OF NON-GOVERNMENTAL STAKEHOLDER ACTIVITIES AND NEEDS

## 3.1 METHODS OF OBTAINING STAKEHOLDER INPUT

The Task Force wished to determine the needs of various biomedical waste stakeholders in British Columbia. Since the Task Force is composed of representatives from Government agencies, its members usually represented the needs and concerns of B.C. Government agencies in general. However, the needs of non-governmental stakeholders were also considered to be very important, so the Task Force requested the opportunity for person-to-person or written communication. A list of agencies invited is shown in Appendix 3.1.

The Task Force was also invited to tour Lions Gate Hospital, Saanich Peninsula General Hospital and the Capital Regional District Public Health Unit to review current biomedical waste handling and disposal practices, and to meet with hospital staff and administrators to discuss their concerns and needs.

The following stakeholders provided the Task Force with briefs:

Personal Briefs

College of Pharmacists of B.C.
Government Refuse Collection and Disposal Association
Capital Regional District
Capital Regional District Public Health Unit
B.C. Veterinary Medical Association
B.C. Biomedical Laboratories Ltd.
B.C. Association of Laboratory Physicians/Island Medical Laboratories
Hospital Administrators Association of B.C./St. Pauls Hospital
BC. Health Association
Registered Nurses Association of B.C.
Vancouver General Hospital
Metropolitan Clinical Laboratories Ltd.
Clinical Laboratory Management Association
B.C. Special Waste Services
BFI Medical Waste Systems
College of Dental Surgeons of B.C.
Lions Gate Hospital
Saanich Peninsula General Hospital
Security Environmental Systems Inc.
Wastech Services Ltd.
B.C. Special Waste Advisory Committee

Written Briefs

British Columbia Society of Prevention of Cruelty to Animals

## 3.2 NON-GOVERNMENTAL AGENCY OBSERVATIONS

Based on meetings with stakeholders, it appears that there is a great disparity in opinion over the hazards associated with the management of biomedical wastes. While it appeared that the general consensus of hospital representatives was that biomedical wastes are no more hazardous than the regular refuse waste stream, other stakeholders felt that biomedical wastes present a potential severe hazard and as such are deserving of special precautionary measures to reduce exposure potential (B.C. Task Force on Biomedical Waste Management, February 1988). The Capital Regional District recommended that infectious wastes coming from biomedical waste generators be handled as hazardous waste, with appropriate precautionary measures being carried out (Williams, 1988).

Hospital personnel often suggested that current infection control programs in place at hospitals are more than adequate for the protection of staff and the general public from exposure to biomedical wastes. The hospitals meeting with the Task Force stated they follow some form of waste segregation for biomedical wastes; however, some variation in waste categories, handling requirements, packaging requirements and packaging materials were noted.

On the other hand, the B.C. Special Waste Advisory Committee indicated it observed generally poor management of biomedical wastes from hospitals and other medical facilities. However, the major concern is not with inhouse handling of the wastes, but rather with the ultimate disposal of these wastes (B.C. Task Force on Biomedical Waste Management, December 1987).

The Task Force's tour of the North Vancouver solid waste transfer station and subsequent meeting with Wastech Services Ltd., indicated that despite waste segregation measures, biomedical wastes continue to be disposed of in the regular refuse waste stream. Incidents have occurred where biomedical wastes have arrived at these facilities in regular green garbage bags (B.C. Task Force on Biomedical Waste Management, June 1988). Biomedical wastes at this facility have been compacted and, packages burst open, scattering the wastes throughout. Both representatives from the North Vancouver transfer station and Wastech Services Ltd. stated that this creates a perceptual problem and increases public and worker potential for exposure to these wastes (B.C. Task Force on Biomedical Waste Management, December 1987; B.C. Task Force on Biomedical Waste Management, June 1988).

There was a consensus by stakeholders that the disposal of sharps presents a unique problem. While virtually all generators of biomedical wastes use some form of waste segregation for sharps, suitable disposal options for such wastes are limited. For the Lower Mainland, both the Greater Vancouver Regional District and the City of Vancouver do not accept sharps for disposal at their landfills or transfer stations, even if they have been autoclaved or otherwise rendered non-infectious, because the sharps remain intact (B.C. Task Force on Biomedical Waste Management, February 1988).

With their inability to deal with large waste volumes, the deterioration of disposal equipment and the closure of municipal landfills to biomedical wastes, many of the stakeholders have contracted with BFI Medical Waste Systems for shipment of their wastes to the United States for disposal. A number of stakeholders expressed reservations about entering into costly long-term agreements for waste disposal, and also expressed concern about the potential for the United States border to close to shipments of biomedical wastes (B.C. Task Force on Biomedical Waste Management, December 1987; B.C. Task Force on Biomedical Waste Management, February 1988).

Several companies, including BFI Medical Waste Systems, Security Environmental Systems Inc. and B.C. Special Waste Services, all expressed an interest in the possibility of developing biomedical waste facilities within the Province.

Hospital administrators meeting with the Task Force stated they would like to be self sufficient in meeting all of their waste disposal needs. However, both Lions Gate Hospital and Saanich Peninsula General Hospital representatives indicated they would consider the use of a central disposal facility capable of handling all of their wastes, if it were available and the costs for disposal reasonable (B.C. Task Force on Biomedical Waste Management, December 1987; B.C. Task Force on Biomedical Waste Management, January 1988).

Representatives of Metropolitan Clinical Laboratories Ltd. and the Clinical Laboratory Management Association also stated they would like to see the development of a central disposal facility for biomedical wastes, where wastes could be sent without requiring pretreatment (B.C. Task Force on Biomedical Waste Management, February 1988; Reynolds, 1988).

Several stakeholders meeting with the Task Force stated that they are reserving their decision on the type of management system or disposal equipment that they will purchase, until the Task Force has completed its report and made its recommendations (B.C. Task Force on Biomedical Waste Management, December 1987; B.C. Task Force on Biomedical Waste Management, February 1988).

A number of stakeholders stated that the Task Force should address management strategies for the storage, collection and disposal of outdated drugs from physicians, hospitals and large animal veterinarians. Current disposal practices for these products include returning them to the manufacturers, incineration and disposal in the normal refuse waste stream. The College of Pharmacists of B.C. representative stated there is potential for large volumes of outdated drugs from physicians and medical clinics (B.C. Task Force on Biomedical Waste Management, February 1988).

The B.C. Veterinary Medical Association suggested that the Task Force should assess the hazards associated with the landfill disposal of animal carcasses and should also investigate the production of pet food from rendering plants. It was suggested that rendering plants may not necessarily discriminate between infected and non-infected meat and will often stain meats to make them appear red (B.C. Task Force on Biomedical Waste Management, February 1988). The Society of Prevention of Cruelty to Animals noted concerns with the disposal of large animals, particularly those destroyed by barbituates, and the subsequent impacts on wildlife (B.C. Society of Prevention of Cruelty to Animals, 1988). This organization recommended landfill disposal of carcasses be done in separate cells, with daily cover.

## 3.3 DISCUSSION

In general, the stakeholders welcomed the formation of the Task Force and expressed a desire for recommendations for the management of these wastes and options to rectify current problems.

Perceptions of the hazards presented by biomedical wastes and opinions as to what waste categories are potentially infectious were found to range widely between stakeholders.

However, all stakeholders agreed that used sharps are a potential hazard and present a unique problem for disposal.

While existing inhouse management practices for biomedical wastes in health care facilities may not be a major concern, problems can arise once these wastes are sent for off-site disposal, and incidents occur where biomedical wastes arrive with the regular waste streams at municipal disposal facilities.

There appeared to be an expectation by stakeholders that the Task Force will generate Provincial guidelines for the management of biomedical wastes and that the Task Force report will include management strategies for the collection and disposal of biomedical wastes.

Private sector interest in managing biomedical waste was expressed and may provide an alternative to on-site treatment and disposal of biomedical wastes. One company currently operates in this capacity and is providing such services to a number of health care facilities.

The following list summarizes the major stakeholder needs:

1. A definition of biomedical wastes that clearly describes those categories of wastes requiring special handling.

2. Provincial biomedical waste guidelines specifying requirements for:

    - segregation
    - handling
    - packaging
    - on-site transport
    - on-site storage
    - pre-treatment
    - disposal
    - off-site storage
    - off-site transportation
    - spill or accident cleanups
    - contingency planning

    It was recommended that the management system must be very simple and easy to implement. Guidelines should include requirements for the operation of storage, treatment and disposal technologies.

3. Methods for disposing of sharps, requested by all stakeholders.

4. Collection depots or staging areas established where biomedical wastes from various sources could be dropped off for subsequent disposal at an acceptable facility.

5. A central facility established that would meet all their disposal requirements for both biomedical and non-biomedical wastes and that could eliminate the need for pre-treating biomedical wastes.

6. Stakeholder self-sufficiency in meeting biomedical waste disposal requirements (a few stakeholders).

7. Education programs for hospital staff and administration on the current problems associated with disposing of biomedical wastes in the regular waste stream.

8. Strategies that anticipate the loss of current biomedical waste management options.

9. A review of the practices of disposing of animal carcasses at municipal landfills. This review should not be limited just to carcasses from laboratories, hospitals, veterinary clinics and the SPCA.

10. Address the disposal of outdated drugs and drug samples coming from medical offices and medical clinics.

11. The development of Provincial biomedical waste guidelines and available disposal options for chemicals and solvents.

12. A review of on-site disposal of radioactive materials at hospitals and establishment of cut-off levels of radioactivity for which hospitals may dispose of these materials.

13. Information on biomedical waste management services being offered by the private sector.

14. Study of the practices and impacts of using and disposal of animals containing barbituates and infectious organisms.

## 3.4 REFERENCES

B.C. Society of Prevention of Cruelty to Animals, 1988. Brief to the B.C. Task Force on Biomedical Waste Management, March 2, 1988.

B.C. Task Force on Biomedical Waste Management, 1987. Minutes of Task Force Tour of Lions Gate Hospital, Thursday, December 3, 1987.

B.C. Task Force on Biomedical Waste Management, 1987. Minutes of Task Force Meeting Number 3, Thursday, December 3, 1987.

B.C. Task Force on Biomedical Waste Management, 1987. Minutes of Task Force Meeting with the Special Waste Advisory Committee, Wednesday, December 9, 1987.

B.C. Task Force on Biomedical Waste Management, 1988. Minutes of Task Force Tour of Saanich Peninsula General Hospital, Wednesday, January 20, 1988.

B.C. Task Force on Biomedical Waste Management, 1988. Minutes of Task Force Meeting with Stakeholders, Monday, February 22, 1988.

B.C. Task Force on Biomedical Waste Management, 1988. Summary of Task Force Meeting with Stakeholders, Monday, February 22, 1988.

B.C. Task Force on Biomedical Waste Management, 1988. Minutes of Task Force Meeting with Security Environmental Systems Inc., Monday, April 11, 1988.

B.C. Task Force on Biomedical Waste Management, 1988. Minutes of Task Force Meeting with Ted Rattray, Waste Tech, Monday, June 20, 1988.

Reynolds, H.A., 1988. Memorandum to: Task Force on Biomedical Waste Management, Metropolitan Clinical Laboratories Ltd., February 22, 1988.

Williams, M.C., 1988. Pathological Waste Incinerator, Staff Report, Capital Regional District, Engineering Department to the Sanitation and Water Committee, February 3, 1988.

# 4.0 TASK FORCE QUESTIONNAIRE SURVEY

## 4.1 SURVEY GOALS

The survey's main objective was to gather information about the current waste management practices of biomedical waste generators in British Columbia and to determine if there is a need for improved facilities for disposing of the biomedical wastes. The survey was carried out by sending questionnaires to various facilities and compiling the information received. Two types of questionnaire were developed: one was specifically tailored to suit hospitals, the largest biomedical waste generators, and the other was structured to suit facilities other than hospitals. The questionnaires covered a wide range of waste management aspects such as: classification and generation rates for hospital wastes, segregation and packaging, storage and transport, pretreatment and disposal methods for biomedical waste and hospital waste in general.

The survey was meant to investigate the trends in biomedical waste management in the Province. The identity of the participating generators was not disclosed in the tabulated data.

## 4.2 REVIEW OF QUESTIONNAIRES USED ELSEWHERE

In developing questionnaires, the Task Force reviewed those developed by other jurisdictions for the assessment of biomedical waste management practices. The questionnaires reviewed came from the following sources:

- Task Force of the Hospital Council of Metropolitan Toronto
- Survey of Hospital Waste in Alberta Health Care Institutions
- Ohio Department of Health Summary of Results of Landfill Survey and Hospital Survey
- Seattle-King County Medical Waste Questionnaire

## 4.3 TASK FORCE QUESTIONNAIRE

The questionnaires developed and used by the Task Force are shown in Appendix 4.1.

## 4.4 GENERATORS CONTACTED THROUGH THE QUESTIONNAIRE SURVEY

Six generator groups were contacted via questionnaire:

| | |
|---|---|
| Group I: | hospitals and outpatient clinics |
| Group II: | veterinary clinics and hospitals |
| Group III: | general physicians and family doctors |
| Group IV: | dentists and certified dental specialists |
| Group V: | blood transfusion service |
| Group VI: | university animal care facilities |

### Group I

This group includes: general acute care hospitals, extended care hospitals, specialized treatment centres (cancer, rehabilitation, mentally retarded, physically handicapped), federal hospitals and outpatient clinics. The questionnaire was sent out to all 138 facilities in B.C. Sixty-three (63) responses were received, which represents a return rate of 46%. The participating facilities have a combined total number of beds of 12,987 which represent 64% of the total number of beds (20,296) available in B.C. (B.C. Ministry of Health, 1988).

### Group II

The mailing list was provided to the Task Force by the British Columbia Veterinary Medical Association. The questionnaire was sent to 116 out of 298 veterinary clinics and hospitals in B.C. Seventeen (17) responses were received, which represents a 15% return rate.

### Group III

The mailing list was provided to the Task Force by the B.C. Medical Association. The questionnaire was sent to 75 out of 2358 general practitioners in B.C. Four (4) responses were received, which represents a 5% return rate.

### Group IV

The mailing list was provided to the Task Force by the College of Dental Surgeons of British Columbia. The questionnaire was sent to 90 out of 1845 dentists practising in B.C. Eight (8) responses were received, which represents a 9% return rate.

## 4.5 RESULTS OF THE SURVEY

Summary results of the hospital questionnaire survey are contained in Appendix 4.0 under the following headings:

| | |
|---|---|
| Appendix 4.2 | General Hospital Facility Information |
| Appendix 4.3 | Disposal Methods Used for Various Waste Categories |
| Appendix 4.4 | Segregation and Packaging of Biomedical Wastes |
| Appendix 4.5 | Incinerator Data for Hospitals |

### 4.5.1 Group I: Hospitals, Outpatients Clinics, Specialized Treatment Centres

The 63 responses were further divided in 4 main groups according to the geographical area and the size of the community: Greater Vancouver, Greater Victoria, Major Urban (population range: 15,000-100,000), and Small Community (population less than 15,000) in order to facilitate statistical interpretation of the survey results and evaluation of patterns and trends.

#### Biomedical Waste Generation Rate

The reported biomedical waste generation rates have a wide range of values, anywhere from 0.02 to 4.45 kg/bed/day. The size of facility did not seem to influence the generation rate, although there is the perception that, generally, more services mean more waste. The average biomedical waste generation rate, based on 41 individual generation rates reported, in Table 4.1, was calculated to be 0.78 kg/bed/day which is higher than the 0.5 kg/bed/day generation rate cited in other literature (Bhattacharyya, 1988). The differences observed in biomedical waste generation rates may be due to the

# TABLE 4.1

## BIOMEDICAL WASTE GENERATION RATES REPORTED BY HOSPITALS RESPONDING TO TASK FORCE SURVEY

| COUNT | No | Location | Type of facility | Beds | BMW kg/bed/day |
|---|---|---|---|---|---|
| 1 | 61 | GREATER VANC | ACUTE & EXT CARE | 242 | 0.02 |
| 1 | 12 | SMALL COMM | GEN | 124 | 0.02 |
| 1 | 1 | SMALL COMM | GEN | 71 | 0.03 |
| 1 | 17 | SMALL COMM | GEN | 30 | 0.03 |
| 1 | 22 | SMALL COMM | GEN | 68 | 0.03 |
| 1 | 5 | SMALL COMM | GEN | 12 | 0.05 |
| 1 | 7 | SMALL COMM | GEN | 48 | 0.06 |
| 1 | 40 | SMALL COMM | GEN | 25 | 0.06 |
| 1 | 21 | SMALL COMM | GEN | 18 | 0.08 |
| 1 | 28 | SMALL COMM | ACUTE & EXT CARE | 32 | 0.09 |
| 1 | 48 | GREATER VANC | GEN | 600 | 0.09 |
| 1 | 35 | SMALL COMM | GEN | 220 | 0.12 |
| 1 | 6 | SMALL COMM | GEN | 57 | 0.13 |
| 1 | 44 | VICTORIA | ACUTE & EXT CARE | 515 | 0.14 |
| 1 | 30 | MAJOR URBAN | ACUTE & EXT CARE | 350 | 0.15 |
| 1 | 11 | SMALL COMM | GEN | 55 | 0.16 |
| 1 | 52 | GREATER VANC | GEN | 187 | 0.17 |
| 1 | 62 | GREATER VANC | TERT & OBSTET | 120 | 0.19 |
| 1 | 63 | GREATER VANC | GEN | 975 | 0.19 |
| 1 | 4 | SMALL COMM | OUTPATIENT CLINIC | 7 | 0.20 |
| 1 | 19 | SMALL COMM | CDN FORCES | 12 | 0.20 |
| 1 | 32 | SMALL COMM | GEN | 7 | 0.20 |
| 1 | 54 | GREATER VANC | ACUTE & EXT CARE | 330 | 0.33 |
| 1 | 29 | MAJOR URBAN | GEN | 280 | 0.36 |
| 1 | 37 | SMALL COMM | GEN | 42 | 0.39 |
| 1 | 51 | GREATER VANC | ACUTE & EXT CARE | 175 | 0.42 |
| 1 | 39 | SMALL COMM | CDN FORCES | 6 | 0.71 |
| 1 | 2 | MAJOR URBAN | ACUTE & EXT CARE | 265 | 0.73 |
| 1 | 15 | SMALL COMM | GEN | 93 | 0.74 |
| 1 | 49 | GREATER VANC | GEN | 323 | 0.79 |
| 1 | 33 | SMALL COMM | GEN | 21 | 0.91 |
| 1 | 55 | GREATER VANC | GEN | 720 | 1.04 |
| 1 | 20 | MAJOR URBAN | GEN | 412 | 1.08 |
| 1 | 34 | SMALL COMM | GEN | 39 | 1.10 |
| 1 | 42 | SMALL COMM | ACUTE & EXT CARE | 468 | 1.83 |
| 1 | 36 | SMALL COMM | ACUTE & EXT CARE | 235 | 2.55 |
| 1 | 56 | GREATER VANC | EXT CARE | 240 | 2.71 |
| 1 | 43 | VICTORIA | ACUTE & EXT CARE | 770 | 2.91 |
| 1 | 24 | SMALL COMM | GEN | 37 | 3.24 |
| 1 | 53 | GREATER VANC | GEN | 601 | 3.48 |
| 1 | 58 | GREATER VANC | ACUTE | 530 | 4.45 |
| 41 |  |  |  | 9362 |  |

small sample size responding to the Task Force's survey, as well as due to the variation in biomedical waste classification schemes used by generators of biomedical wastes. As such, generation rates and volumes for biomedical wastes determined by the Task Force should be interpreted cautiously and be considered as estimates of the biomedical waste volume in the Province. On the basis of the survey's average generation rate for biomedical waste and the number of hospital beds in the Province, it can be estimated that the quantity of biomedical waste produced in B.C. is 15.8 tonnes per day or about 5800 tonnes per year.

## Waste Grouping Used

The waste grouping used by the surveyed hospitals were either the same categories as suggested by the Biomedical Task Force Questionnaire or other groupings such as:

- sharps
- bio hazard

- sharps
- chemicals and pharmaceuticals
- potentially infectious biological waste
- potentially infectious non-biological waste

- human waste, general
- sharps
- chemicals and pharmaceuticals

- drugs
- sharps
- lab waste
- isolation/infectious

- blood
- infectious material
- antineoplastic

- infectious
- non-infectious

- infectious
- non-infectious
- sharps

- blood
- infectious material
- antineoplastics

It was noted from the way a questionnaire was filled out that the respondents may have been confused by the definitions and by the way several questions were worded.

The fact that the hospitals reported the use of the Task Force's nine working categories in classifying their waste does not imply that all the nine categories are produced by them. For example, infectious animal wastes are obviously not produced by Group I of the survey.

## Disposal Practices for Various Types of Biomedical Wastes

### A. Greater Victoria Hospitals

Disposal practices in Greater Victoria are largely influenced by the common management of four of the city hospitals by the Greater Victoria Hospital Society (GVHS). The Society operates one incinerator at the Royal Jubilee Hospital, which serves the incineration needs of the other three hospitals within the Society and of several other hospitals in Greater Victoria. All biomedical waste generated by the four hospitals managed by the GVHS is being incinerated at the Royal Jubilee Hospital. In addition to biomedical waste, the Royal Jubilee Hospital incinerator is incinerating all other types of refuse that the Royal Jubilee Hospital is producing. The incineration service offered by the Royal

Jubilee Hospital to hospitals outside the GVHS is more discriminately used by those hospitals which use off-site incineration only for sharps, infectious and radioactive materials (Table A4.5 in Appendix 4.3). The Greater Victoria hospital outside the GVHS, which responded to our questionnaire, indicated that microbiologicals (non-infectious) are landfilled with general refuse and that chemicals and pharmaceuticals are either sewered or returned to the suppliers.

### B. Greater Vancouver Hospitals

In the Greater Vancouver area there are a number of hospitals (Grace, Childrens', St. Vincent's) that are using the Shaughnessy hospital incinerator. Off-site incineration of various categories of biomedical waste is also accomplished by contracting out disposal with specialized firms such as BFI Medical Waste Systems (BFI) which uses an incinerator located in Bellingham. A number of hospitals are using only their own incinerators, and some hospitals are using their own incinerators as well as the BFI services. BFI is mostly used for sharps, anatomical, laboratory and chemotherapy wastes. There is, however, one hospital which is using exclusively BFI for disposal of all the biomedical waste it generates. There are a number of hospitals within the Greater Vancouver area, Lower Fraser Valley, and the Vancouver Island considering service contracts with BFI for disposal of all or a portion of their biomedical wastes. With one exception, all hospitals using or considering BFI are equipped with an incinerator. It appears that there are two factors spurring hospitals to look for an alternative disposal facility other than their own incinerators:

- the poor condition of the hospital incinerators,
- lack of capacity of existing hospital incinerators for constantly increasing volumes of biomedical wastes.

One hospital in the Lower Fraser Valley provides incineration services for hospitals within the Greater Vancouver area which lack an incineration facility (one reported case in this survey).

Landfilling is being used as a method of disposal of biomedical waste by 7 of the 16 responding hospitals. The extent to which landfilling is used varies from landfilling all the biomedical waste to landfilling only liquid human anatomical and infectious microbiologicals (pretreated by autoclaving or chemicals prior to disposal) or only non-infectious biomedical waste.

The sewer system is universally used to dispose of biological wastes. There are several hospitals which also sewer pretreated liquid human anatomical waste and laboratory chemicals.

Table 4.2 provides an overview of current biomedical waste disposal practices being used by Greater Vancouver hospitals responding to the survey.

### C. Major Urban Hospitals

All hospitals which participated in the survey from other major urban areas of the Province have reported the availability of an incineration facility on their premises. The preferred method of disposal of their biomedical waste was mainly on-site incineration. The odd exception was reported for solid anatomical waste which several

## TABLE 4.2

## TASK FORCE'S HOSPITAL SURVEY RESULTS OF CURRENT BIOMEDICAL WASTE DISPOSAL PRACTICES FOR GREATER VANCOUVER HOSPITALS

| | WASTE CATEGORIES | | | | | |
|---|---|---|---|---|---|---|
| Disposal Mechanism | Chemical & Pharmaceutical | Sharps | Microbiological | Solid[2] Anatomical | Infectious[3] Waste | Antineoplastic |
| On-site incineration | 40% | 47% | 60% | 71% | 67% | 50% |
| Off-site incineration | 20% | 47% | 20% | 14% | 33% | 38% |
| Incineration or sewer | 13% | | | | | 12% |
| Incineration or return[4] | 13% | | | | | |
| Incineration or landfill | | | | | | |
| Return | 7% | | | | | |
| Return or sewer | | | | | | |
| Sewer | 7% | | | | | |
| Landfill | | 7% | 20%[1] | 14% | | |

---

[1] Autoclaved prior to landfill disposal.

[2] Assumed to be equivalent to "Solid Human Anatomical Wastes" as defined in Chapter 2.0.

[3] This is a more general grouping than the categories used by the Task Force: it does not include sharps but may include microbiologicals.

[4] Return refers to waste pharmaceuticals returned to the supplier.

hospitals are incinerating in off-site facilities (crematoria), a practice which is dictated by the non-pathological capabilities of their incinerators. Landfilling was occasionally reported for disposal of sharps and microbiologicals which were, however, pretreated before to disposal to land.

A summary of biomedical waste disposal practices being utilized by hospitals in major urban areas, excluding Greater Victoria and Greater Vancouver, is provided in Table 4.3.

### D. Small Communities Hospitals

All the outpatient clinics and Canadian Forces Hospitals are grouped under this classification and they will be discussed first as they have a small contribution to the overall volume of biomedical waste generated in the Province.

#### Outpatient Clinics

From 8 outpatient clinics participating in the survey, 3 are equipped with pathological incinerators and are disposing of most of their biomedical waste by incineration on premises. The rest of the outpatient clinics reported a mixed disposal strategy with emphasis on off-site incineration of most of the biomedical type waste. The off-site incineration facilities belong either to a forest product company or to a proximate health care facility.

#### Canadian Forces Hospitals

The two Canadian Forces Hospitals in B.C. have responded to the questionnaire. They are both equipped with pathological incinerators and use exclusively incineration for disposal of their biomedical waste.

#### Other Small Community Hospitals

The survey includes the responses of 25 facilities located in small communities. The facilities are either general acute or acute and extended care hospitals, with a large range of bed numbers, anywhere from 7 to 468.

Table 4.4 presents the current disposal practices for biomedical wastes generated by small community hospitals.

The off-site incineration facilities used by the small community hospitals are either a nearby hospital incinerator or a municipal incinerator (such as Duncan and Ladysmith municipal incinerators).

### Pretreatment Prior to Disposal

The survey indicates (see Appendix 4.3) that 27 of the health care facilities responding to the questionnaire do not pretreat any of the biomedical waste types prior to disposal. This represents 43% of the surveyed hospitals. The rest of the hospitals (57%) do apply one of three forms of:

- bleaching
- autoclaving
- other (formalin, decaying by storage for radioactive material)

## TABLE 4.3

## TASK FORCE'S HOSPITAL SURVEY RESULTS OF CURRENT BIOMEDICAL WASTE DISPOSAL PRACTICES FOR MAJOR URBAN AREAS

| | WASTE CATEGORIES | | | | | |
|---|---|---|---|---|---|---|
| Disposal Mechanism | Chemical & Pharmaceutical | Sharps | Microbiological | Solid[1] Anatomical | Infectious[2] Waste | Antineoplastic |
| On-site incineration | 100% | 71% | 71% | 50% | 100% | 83% |
| Off-site incineration | | | | 50% | | 17% |
| Incineration or sewer | | | | | | 12% |
| Incineration or return[3] | | | | | | |
| Incineration or landfill | | | | | | |
| Return | | | | | | |
| Return or sewer | | | | | | |
| Sewer | | | | | | |
| Landfill | | 29% | 29% | | | |

[1] Assumed to be equivalent to "Solid Human Anatomical Wastes" as defined in Chapter 2.0.
[2] This is a more general grouping than the categories used by the Task Force: it does not include sharps but may include microbiologicals.
[3] Return refers to waste pharmaceuticals returned to the supplier.

# TABLE 4.4

## TASK FORCE'S HOSPITAL SURVEY RESULTS OF CURRENT BIOMEDICAL WASTE DISPOSAL PRACTICES FOR SMALL COMMUNITY HOSPITALS

| | WASTE CATEGORIES | | | | | |
|---|---|---|---|---|---|---|
| Disposal Mechanism | Chemical & Pharmaceutical | Sharps | Microbiological | Solid[1] Anatomical | Infectious[2] Waste | Antineoplastic |
| On-site incineration | 42% | 71% | 69% | 69% | 71% | 65% |
| Off-site incineration | 21% | 20% | 20% | 25% | 17% | 31% |
| Incineration or sewer | 9% | | | | | |
| Incineration or return | 12% | | | | | |
| Incineration or landfill | | | | | | 4% |
| Return | 3% | | | | | |
| Return or sewer | 3% | | | | | |
| Sewer | 9% | | | | | |
| Landfill | | 9% | 11% | 6% | 11% | |

[1] Assumed to be equivalent to "Solid Human Anatomical Wastes" as defined in Chapter 2.0.
[2] This is a more general grouping than the categories used by the Task Force: it does not include sharps but may include microbiologicals.
[3] Return refers to waste pharmaceuticals returned to supplier.

The pretreatment is applied discriminately to various groups of biomedical waste. It has been noted that some hospitals which are landfilling or off-site incinerating biomedical waste are pretreating the waste and that some hospitals are not.

There are also types of biomedical wastes that are automatically treated regardless of the final disposal method. The most frequent type of biomedical waste pretreated before disposal is waste from the hospital microbiological laboratories. Some hospitals pretreat sharps and blood products. The procedures vary with each hospital and it was difficult to summarize the reported data.

## Segregation and Packaging

The survey generated a broad data base on segregation and packaging of biomedical waste. As general comments on the subject, segregation is being carried out by most hospitals and is accomplished by the use of specialized containers, colour coded packaging and labels (Appendix 4.4).

## Hospital Incinerators

The data are organized according to geographical area and size of the community and is given in Appendix 4.5. There are a few common characteristics for all hospital incinerators that will be presented first, prior to presenting and discussing the information in each table:

- all hospital incinerators are manual fed,
- all run on auxiliary fuel (continuously or temporarily),
- none is equipped with air pollution control systems such as cyclones, multiclones, wet or dry scrubbers, fabric filters,
- none is provided with a heat recovery system,
- the ash produced is taken to landfills.

The hospital incinerators are of various makes and various ages. They are classified as either pathological or non-pathological, but as it was remarked by some of the respondents, some of the older type pathological incinerators may not meet the current technological and operational standards of today's pathological waste incinerators.

As it was previously remarked in this report, there are several situations in B.C. where a hospital is providing its incineration services to a group of other hospitals, to another hospital, or to small health care facilities such as outpatient clinics. The most known situations of this type are in Greater Victoria (Royal Jubilee Hospital) and Vancouver (Shaughnessy Hospital).

### A. Greater Victoria Hospitals

Table A4.13 in Appendix 4.5 contains all the information on incineration facilities at the surveyed hospitals. Since there is only one incinerator reported further discussion is not necessary. The only noteworthy comment is that made by the GVHS in their response, that the Royal Jubilee Hospital incinerator has inadequate air pollution controls, its present location is in the way of planned future hospital expansion and that the action which will be taken by GVHS to remedy the situation will depend on the findings and recommendations of this Task Force.

### B. Greater Vancouver Hospitals

From the 16 hospitals which responded to the questionnaire, 7 hospitals (44%) do not have an incinerator. The rest of the hospitals reported pathological and non-pathological incinerators at a ratio of 6 to 3. Out of the 9 reported incinerators, 3 were installed after 1980 and 6 before 1980 (as far back as 1956). According to the reported hours of operation, two of the incinerators are largely underutilized which may be due to their poor condition. All incinerators have been subjected to some kind of renovations but only 4 of them are rated in good condition by their operators.

As a contingency plan in case the of incinerator failure, the hospitals reported either storage of the biomedical waste on-site until incinerator is repaired or use of an off-site incinerator. Two hospitals reported no contingency plan.

### C. Major Urban Hospitals

All the responding major urban hospitals reported that they are equipped with incinerators. Out of the 7 reported incinerators, 4 are pathological and 3 are non-pathological. Three were installed before to 1980 (in the 1960's) and 3 were installed after 1980 (one installation year not reported). With one exception, all incinerators seem to be underutilized (short weekly operating time) which indicate excess capacity since the incinerators condition is reported as being good. Gas is used as auxiliary fuel. The contingency plans reported are similar to hospitals in the Greater Vancouver area. Two hospitals reported no contingency plan, commenting that they do not have a plan because it was not needed.

### D. Small Community Hospitals

From the 35 respondents (including the outpatient clinics and Canadian Forces hospitals, 27 facilities reported an incinerator on their premises. Almost 60% of the incinerators are pathological (16). Eight incinerators have been installed after 1980; the year of installation for the rest is anywhere from 1958 to 1980. The incinerator size appears to be directly proportional to the number of beds at the health care facility. It was previously noted in this chapter that 3 of the 8 outpatient clinics are equipped with pathological incinerators. Sixteen respondents rated their incineration and 11 (69%) out of 16 reported them in good operational condition condition and the rest of 5 either fair or poor.

From the reported numbers of hours of operation it appeared that there is excess capacity at almost all facilities. About 45% of the incinerators use oil and 55% use gas as auxiliary fuel. As contingency plan, they reported storage on-site, off-site incineration, and landfilling. Several hospitals do not have a contingency plan.

### 4.5.2 Group II: Veterinary Clinics and Hospitals

The following points summarize the results of the survey of veterinary facilities:

- Number of animals generated per day/facility: 18
- Total solid waste generated per month/facility: 800 kg
- Biomedical waste generated per month/facility: 180 kg (23% of the total waste generated.

According to this generation rate, the annual quantity of biomedical waste generated by the veterinary hospitals and clinics is 644 tonnes. This is almost five times higher than the quantity estimated by a 1987 EPS study in which the calculation was based on US EPA generation factors. It is believed that the data generated by this survey are more reliable as the generation rates are less artificial than the American factors. However, it was remarked by the respondents to the questionnaire that category 3 of the questionnaire was misleading as carcasses, that constitute its major component by weight, are usually not infectious. From another survey (Beauchemin, 1988) it is concluded that about 700 tonnes of animal care related biomedical waste is being annually incinerated in the GVRD. As our survey did not include the SPCA centres (which handle a large quantity of carcasses in their own incinerators) this quantity (including the SPCA hospitals) compared well with that generated by our survey. A reasonable estimate for the whole Province (including the SPCA centres) would be that about 1000 tonnes of biomedical waste per year is generated by the veterinary clinics and hospitals and SPCA centres.

- Infectious animal anatomical solid and liquid waste (which includes carcasses) is produced in the largest quantity: 157 kg per month (87% of the biomedical waste generated)/facility.

  It appears that infectious and non-infectious carcasses were reported indiscriminately under this category, therefore, the quantities of biomedical waste generated by the veterinary clinics and hospitals were quite large relative to other reports (Environment Canada, 1987).

  Note: The numbers above are based on the arithmetic mean of the quantities given in the responses, except for the B.C. SPCA Vancouver Regional Branch response, which was considered an outlier due to the size and nature of the facility.

- Cost for disposal of biomedical waste varies largely. The responses indicated costs anywhere from nothing to $3/kg for infectious animal anatomical waste.

- Most veterinary clinics and hospitals perform some kind of segregation of the biomedical waste. As a general rule, segregation involves at least bagging of the animal carcasses separately from the other types of refuse and freezing them until disposal time. There are, however, facilities which bag everything similarly to regular garbage. Sharps are usually separated and contained in rigid containers of various types. No special labelling is used and the bags and containers used for packing are diverse and in many cases not standardized (regular garbage bags for carcasses and used metal cans for sharps). Taping is the general mode of sealing the bags or containers.

- Segregation is done by the clinic staff. Within the facility the wastes are transported in their final packaging. Storage time varies anywhere from 3 hours to 30 days. Carcasses are always stored in the freezer if stored on-site. This is the most frequent situation as the veterinary clinics and hospitals do not have pathological incinerators on-site.

- From the transportation point of view, biomedical waste is clearly divided in two categories: carcasses, which are taken to the incineration site by SPCA crews or clinic staff (in private vehicles) and the rest of the biomedical waste (including sharps) which is taken to the disposal site by municipal refuse collection crews or private garbage collectors.

- Off-site incineration is the most frequently used method of disposal for carcasses. Large farm animal carcasses are often buried on farm land. Among the off-site incineration facilities used for disposing of the animal carcasses are the SPCA Animal Shelter incinerators, designated crematoria and, on Vancouver Island, the Cowichan Valley Regional District incinerator, south of Duncan. Larger clinics and hospitals (Surrey Animal Hospital, South Surrey Veterinary Hospital, Kerrisdale Veterinary Hospital) are equipped with their own incinerator (Beauchemin, 1988).

- Animal biological waste is sewered. The remainder of the biomedical waste goes to municipal disposal sites, which until not too long ago were exclusively landfills. With the starting of the Burnaby Incinerator, the North Shore refuse is being incinerated, via the North Shore Transfer Station.

- The majority of veterinary hospitals and clinics do not pretreat their biomedical waste prior to landfilling or sewering. If freezing is considered a form of pretreatment, then all carcasses are treated before incineration.

- Except for the SPCA Vancouver Regional Branch, no other facility reported a contingency plan.

### 4.5.3 Group III: General Physicians and Family Doctors

In view of the poor response to questionnaires sent to individual doctors, it is inappropriate to generalize on their current management practices for biomedical wastes at this time.

### 4.5.4 Group IV: Dentists and Certified Dental Specialists

The questions were answered very differently by the respondents and no averaging was attempted as some respondents referred strictly to the liquid portion of the biomedical waste and some only to its solid components.

- Most dentists segregate the sharps and scrap dental amalgams from the other types of biomedical waste.

- Scrap dental amalgam, specially packaged, is shipped by mail or couriers to re-smeltering facilities.

- Sharps are stored in special containers before their disposal.

- All the solid biomedical waste, including sharps, are handled in a fashion similar to the regular garbage. Some dentists take the sharps to a landfill themselves.

- The liquid portion of the biomedical waste (saliva, blood) and some pulverized solid matter go into the sewer system.

- No waste is pretreated prior to disposal.

- Collection and transportation of the biomedical waste to the disposal site is done by municipal and private refuse collection crews.
- The disposal cost for biomedical waste was reported by most dentists as nil, since most of it is handled and disposed of with the general refuse.
- No contingency plan was reported.

### 4.5.5 Group V: Blood Transfusion Service

The blood transfusion service centre in Vancouver is the Provincial centre for the collection, testing, processing and distribution of blood for B.C. and the Yukon. All blood collected at the 2-3 mobile units around the Province is brought to the Vancouver centre, on Oak Street, for testing, processing and distribution. The Vancouver centre generates 8000 L of liquid infectious waste/month and 4000 kg of solid infectious waste/month. The cost to dispose of all waste is $2000/month. BFI Medical Waste Systems is contracted to dispose of all the waste. Collection is once a week and all waste is specially packaged.

### 4.5.6 Group VI: University Animal Care Facilities and Research Laboratories

University "A"

Wastes Generated:
- 5880 kg/month infectious animal solid and liquid wastes (not necessarily infectious)
- 120 kg/month waste sharps

Disposal Methods:

On-site incineration at University A:
- 480 kg/month infectious animal solid wastes
- 120 kg/month waste sharps

Landfilled without pretreatment:
- 4200 kg/month infectious animal solid and liquid wastes

Sewered without pretreatment:
- 1200 kg/month of infectious and animal solid and liquid wastes

University "B"

Wastes Generated:
- 2 kg/month infectious animal solid and liquid wastes
- 30 kg/month waste sharps

Disposal Methods:

Off-site incineration at a Vancouver hospital:
- 2 kg/month infectious animal solid and liquid wastes

Sewered:
- Blood and other liquid wastes are sewered (inconsistent policy on autoclaving these wastes prior to sewer disposal).

Unknown:

- Sharps are packaged prior to disposal, however, disposal method was not stated.

University "C"

Wastes Generated:

- 120 kg/month infectious animal solid and liquid wastes
- 100 kg/month infectious nonanatomical wastes
- 100 kg/month waste sharps
- 800 kg/month infectious microbiological wastes
- 600 kg/month non-infectious bedding

Disposal Methods

Off-site Landfills:

- 100 kg/month sharps
- 600 kg/month non-infectious bedding
- 800 kg/month infectious microbiological wastes (autoclaved prior to disposal)

Off-site Incineration - Contracted to BFI:

- 120 kg/month infectious animal solid and liquid wastes
- 100 kg/month infectious nonanatomical wastes

Sewered:

- 20 L/month infectious animal liquids and other liquid infectious wastes (disinfected or sterilized prior to sewerage)

Costs for disposal of all biomedical wastes:

- $1000/month

The results for university animal care facilities and research laboratories are not in a form that permit complete generalization. In the case of University "A", infectious and non-infectious wastes were not distinguished. Nevertheless, all generate sharps, with a total of 250 kg reported produced per month, and all have some portion of these wastes incinerated, totalling 822 kg/month. A total of 5700 kg/month of infectious and non-infectious material is landfilled.

## 4.6 DISCUSSION

### Group I: Hospitals, Outpatient Clinics, Specialized Treatment Centres.

The results of the Task Force's survey indicate a wide range in biomedical waste generation rates among facilities; however, the average generation rate determined (0.78 kg/bed/day) is close to the average generation rate predicted from the literature of 0.5 kg/bed/day. Deviance in the generation rate may be attributed to the small number of respondents to the questionnaire, and the non-uniform use of definitions and categories of biomedical wastes by the facilities responding.

As summarized in Table 4.5, the majority of hospitals in the Province are currently disposing of biomedical wastes by either on-site or off-site incineration, while lesser numbers of hospitals are disposing of biomedical wastes to the sewer and landfill.

## TABLE 4.5

## SUMMARY OF TASK FORCE QUESTIONNAIRE SURVEY RESULTS FOR DISPOSAL METHODS BEING UTILIZED BY HOSPITALS FOR SPECIFIC WASTE STREAMS

| WASTE TYPE | DISPOSAL METHODS USED[1] | | |
|---|---|---|---|
| | Incineration | Sanitary Landfill | Sanitary Sewer |
| Solid human anatomical waste | 68% | 5% | |
| Liquid human anatomical waste | 54% | 6% | 14% |
| Infectious animal solids & liquid waste | 48% | 5% | |
| Infectious biological solids & liquid waste | 41% | 6% | 40% |
| Infectious nonanatomical waste | 59% | 8% | |
| Waste sharps | 81% | 8% | |
| Infectious microbiological wastes | 54% | 10% | |
| Chemical & pharmaceutical wastes | 71% | 3% | 19% |

[1] From 63 hospitals responding

### Group II: Veterinary Clinics and Hospitals

Carcasses represent 87% of the estimated 1000 tonnes of biomedical waste produced annually by veterinary clinics and hospitals, and SPCA centres in the Province. Their final disposal does not seem to be a problem. Disposal of carcasses is almost always carried out through incineration on-site or off-site.

All the other components of biomedical waste are either sewered or landfilled. Disposal to municipal disposal facilities is carried out through regular refuse collection, and no treatment is applied to any of the waste before disposal.

### Group III: General Physicians and Family Doctors

Insufficient data was obtained to permit a balanced discussion of the types of wastes generated by general physicians and family doctors.

### Group IV: Dentists and Certified Dental Specialists

For dentists, with the exception of sharps and the scrap dental amalgam, all biomedical waste is either sewered or disposed of with the general garbage. After segregation and special packaging, the sharps are not taken to an incineration facility but to a landfill or they are put in the regular refuse disposal container.

The specialized dentists do not seem to generate different quality or quantity of biomedical wastes than the other dentists.

The dentists have the perception that the waste generated by a dental office is essentially no different in bacterial or viral content than that found in public disposal systems and that no special treatment should be applied when disposing of it. It appears that there are no problems with the biomedical waste generated by the dentists as that it is handled satisfactorily by the local disposal services.

### Group V: Blood Transfusion Service

All biomedical wastes generated or processed through the Vancouver centre of the blood transfusion service is currently being managed by BFI Medical Waste Systems and is being shipped to the United States for disposal.

### Group VI: University Animal Care Facilities and Research Laboratories

Universities in the Province currently use incineration, landfill and sewer for the disposal of biomedical waste generated in university laboratories and animal care facilities. While all three disposal mechanisms are reported as being used, the categories of waste being deposited in these systems differs between institutes. Further disparity exists between institutions and even within institutes as to the pretreatment status of wastes being disposed of in landfills or sewers.

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# 5.0 INVENTORY OF BIOMEDICAL WASTE GENERATED IN B.C. AND ELSEWHERE

## 5.1 REVIEW OF INVENTORIES FROM OTHER JURISDICTIONS

The available literature has been reviewed to determine the rate of generation of biomedical wastes from various sources. It appears that most of the information relates to hospital facilities, and very limited data are available for other sources. Unfortunately, as discussed below, the results from these surveys indicate a wide range of waste generation rates. This is primarily due to the use of a number of vague and general terms, such as "biological waste", "pathological waste", "contaminated waste", and "biomedical waste", which have been used to characterize the waste generated.

The definition of biomedical wastes (Type A) used in this section is provided in Appendix 5.1 and is equivalent to that used in a recent report from Environment Canada (Environment Canada, 1988). In general terms, these wastes include: infectious human anatomical waste; infected or contaminated animal anatomical waste; infected or contaminated non-anatomical wastes from any source whatsoever; laboratory wastes and equipment and materials contaminated with those wastes; and any waste produced or used in the production and use of recombinant DNA and hybrid or mutant organisms, animal virus research and synthesis, and animal cell research and production.

### 5.1.1 Hospitals

Hospital waste usually includes both infectious waste and non-infectious refuse. Effective segregation of these two types of waste at the point of generation is not practised at every hospital. As a result, the infectious material can be mixed with a significantly larger volume of general waste produced at the hospital.

Summaries of information on waste generation rates in various Canadian and American hospitals are presented in Tables 5.1 and 5.2. As can be seen from these tables, the rate of waste generation has been expressed on either "per patient per day" or "per bed per day" basis or both, depending on the extent of the survey carried out. It should be noted that the wide variations in the reported data stem presumably from the methods used to estimate the rates on "bed/day" and "patient/day" basis. The methodology of estimation is not always available in the literature. Usually the rate on a "patient/day" basis is derived from the waste/bed/day rate and the bed occupancy rate at the particular hospital. However, sometimes it is also estimated by dividing the total of all waste, including that from in- and out-patients and staff, by the patient population (Rutala, et al, 1983).

The bed occupancy rate in the hospitals in the U.S.A. has been estimated to be between 64 and 86% (Environment Canada, 1988). The average occupancy rate in the U.S.A. reported recently by the Environmental Protection Agency is about 69% (US EPA, 1987). In North Carolina the occupancy rate in 1980 was estimated to be 76% (Rutala, et al, 1983). In Canadian public hospitals, the bed occupancy rate in 1983-1984 has been reported to be 83% (Environment Canada, 1988).

Because of the rising trend in the use of disposable materials, the waste generation rates in hospitals have been increasing in recent years. Therefore, the rate of waste generation can vary significantly from one facility to another, depending on the facility's practice of using disposable materials.

## TABLE 5.1

## Summary of Waste Generation Surveys at Hospitals in Canada

| Source of Information | Year of Survey | Size of Hospital (No. of beds) | Waste Generation Rate | |
|---|---|---|---|---|
| | | | kg/patient/day | kg/bed/day |
| Reaveley, G.H. et al, 1971 | n.a. | 50-900 | 1.6-4.5 | 2.6 |
| Alberta, 1975 | 1975 | 8-1048 | 4.0-5.7 | 1.8-3.5 |
| Environment Canada, 1980 | 1980 | n.a. | n.a. | 1.5-3.9 |
| Health and Welfare Canada, 1984 | 1984 | 124-720 | 2.1-3.5 | 1.5-3.3 |
| Manual J, 1985 | 1985 | 250 | n.a. | 6.0 |
| Sirman, I., 1985 | 1985 | n.a. | n.a. | 2.3-7.7 |

n.a.=information not available

## TABLE 5.2

## Summary of Waste Generation Surveys at Hospitals in the United States

| Source of Information | Year of Survey | Size of Hospital (No. of beds) | Waste Generation Rate | |
|---|---|---|---|---|
| | | | kg/patient/day | kg/bed/day |
| Iglar A.F. et al, 1973 | 1966-1970 | 50 - 1226 | 2.1 - 7.4 | 3.8 |
| Burchinal J.C. et al, 1971 | 1968-1971 | 438 | 1.6 | 1.3 |
| Pollock E.L., 1978 | 1968-1978 | * | 4.4 - 4.8 | 3.0 - 7.5 |
| Minnesota, 1971 | 1971 | 430 | 2.8 | 2.2 |
| Kremer J.G. et al, 1977 | n.a. | n.a. | 7.8 | 6.2 |
| Block S.S. et al, 1977 | n.a. | n.a. | 4.5 - 18.2 | 9.1 |
| Airan D.S. et al, 1980 | 1980 | n.a. | n.a. | 4.3 - 5.8 |
| Anon, 1980 | n.a. | n.a. | 4.5 | n.a. |
| Rutula W.A., et al, 1983 | 1980 | <100 - >500 | 5.9 | 4.1 - 5.2 |
| US EPA, 1987 | n.a. | n.a. | n.a. | 3.6 - 5.9 |

*Several surveys during the period 1968-1978. Only one survey, in 1975 mentions the size of the hospital.
n.a.=information not available

The quantity of waste generated at a hospital is reportedly proportional to the amount and types of care received which is directly related to the number of staff members who provide service (Wallace, et al, 1972). Heavy care units (operating rooms, burn units, intensive care, etc.) are reported to generate about I.6 times more waste than light care units (pediatric, neurology, general medicine, etc.) and twice that in support units (pharmacy and administrative services)(Rutala, et al, 1983). In a survey of North Carolina hospitals, it has been observed that there seems to be a direct relationship between the number of beds and the amount of waste generated (Rutala, et al, 1983).

From Tables 5.I and 5.2, the waste generation rates in Canadian and American hospitals appear to be as follows:

| | |
|---|---|
| Canadian Hospitals | 1.6 - 5.7 kg/patient/day |
| | 1.5 - 7.7 kg/bed/day |
| American Hospitals | 1.6 - 18.2 kg/patient/day |
| | 1.3 - 9.1 kg/bed/day |

The Ministry of the Environment of the Province of Ontario (Ontario, 1986) recommends that in the absence of any actual data, the following values are to be used to estimate the waste quantity:

| | |
|---|---|
| Total biomedical waste (includes special care waste, but excludes kitchen waste) | 6 kg/bed/day |
| Special care waste | 1 kg/special care bed/day |

Environment Canada (Environment Canada, 1988) in a recent report has suggested waste generation rates of 3.34 - 3.83 kg/patient/day and 2.92 kg/bed/day for general waste from hospitals.

In 1980, a study done by McCrae (Environment Canada, 1980) at the Royal Jubilee Hospital in Victoria, indicated the waste generation rate as 1.5 - 3.9 kg/bed/day.

### 5.1.2 Infectious Waste

As mentioned earlier, the infectious waste constitutes a small fraction of the total waste generated in a hospital. The available information on the rate of infectious waste generation in Canadian and American facilities is summarized in Table 5.3. The reported ranges of waste generation rates are 0.04 - 2.36 kg/patient/day and 0.03 - 1.89 kg/bed/day.

Some studies have also expressed the infectious waste amount as a fraction of the total waste generation. The reported data, as shown in Table 5.4, range from 2% to 30% of the total hospital waste. The variability in reported rates of infectious waste appears to be due to the different definitions used to characterize this waste.

## TABLE 5.3

## Summary of Biomedical Waste (Type A) Generation Surveys at Hospitals in Canada and the U.S.A.

| Source of Information | Year of Survey | Size of Hospital (No. of beds) | Waste Generation Rate | |
|---|---|---|---|---|
| | | | kg/patient/day | kg/bed/day |
| Reavely, G.H. et al, 1971 | n.a. | 59-600 | 0.73-2.36 | 0.58-1.89 |
| Alberta. 1975 | 1975 | 76-406 | n.a. | 0.034-0.141 |
| Health and Welfare Canada. 1984 | 1984 | 124-720 | 0.042-0.07 | 0.03-0.066 |
| Manuel, J. 1985 | n.a. | 250 | n.a. | 0.6 |
| Sirman, I. 1985 | 1985 | n.a. | n.a. | 0.75* |
| Kremer, J.G. et al. 1975 | n.a. | n.a. | 0.037 | 0.029 |

n.a.=information not available
*=infectious waste generated from special care beds in surgical rooms, isolation wards and special medical procedure rooms.

## TABLE 5.4

## Infectious Waste Generation in Canadian and American Hospitals

| Source of Information | Percentage of Hospital Waste Considered As Infectious |
|---|---|
| Health and Welfare Canada, 1984 | 2 |
| Manuel, J. 1985 | 10 |
| Burchinal, J.C. et al. 1971 | 25-30 |
| Rutula, W. A. et al. 1983 | 11 |
| US EPA. 1987 | 15 |
| Bleckman, J.R. 1984 | 10 |

### 5.1.3 Other Sources

Not much information is available in the literature on the waste generation rates from other sources. A preliminary study was done by Environment Canada in l984 (Environment Canada, 1984), which was based primarily on an earlier report from the U.S. Environmental Protection Agency (US EPA, 1979). Considering the comparable living style and economic index of both countries, the waste generation factors in these facilities can be assumed to be similar (Environment Canada, 1988).

It should be noted that while in the American report, the waste generation factors have been developed for all the hazardous waste produced from these sources, in the Canadian report, it is assumed that 50% of the total waste from each type of source is biomedical type. Based on this assumption, the average generation rates of biomedical waste from specific sources are estimated to be as follows:

| | |
|---|---|
| Veterinary Services | 52 kg/month/veterinarian |
| Medical and Other Health Laboratories | 6.5 kg/month/employee |
| Research and Development Laboratories | 1545 kg/month/establishment |

The Ministry of the Environment of the Province of Ontario (Ontario, 1986) has recommended that a generation rate of 0.2 kg/patient/day of biomedical waste can be assumed for private and diagnostic laboratories.

## 5.2 BIOMEDICAL WASTE GENERATION IN B.C. FROM LITERATURE BASED GENERATION FACTORS

From the information presented in the previous section, it appears that the following waste generation factors could be assumed as reasonable for preliminary estimates of various types of waste generated in the hospitals in B.C.:

| | |
|---|---|
| Total waste | 4 kg/bed/day |
| Biomedical (Type A) waste | 0.5 kg/bed/day |
| Infectious waste | 10% of total waste |

Based on the hospital bed inventory in the Province, as supplied by the Ministry of Health and the above generation factors, the estimated quantities of wastes generated in various hospitals for the year 1987 are listed in Appendix 5.2. It has been estimated that in 1987, the hospitals produced approximately 81 tonnes/day of total waste; of which the biomedical (Type A) and infectious portions are about 10 and 8 tonnes/day respectively.

## 5.3 DISCUSSION

An estimate of the Provincial volume of biomedical waste generated daily in B.C., 16 tonnes/day, was generated in Chapter 4 based on survey work by the Task Force. Table 5.5 compares the 10 tonnes/day generation rate from an estimate using literature-based generation factors to that of the Task Force. In view of the small sample size used for the Task Force survey, the agreement is good between these two estimates.

## TABLE 5.5

## TOTAL ESTIMATED RATE OF BIOMEDICAL WASTE GENERATED IN B.C. IN 1987

| Estimate Source | Waste Volume (tonnes/day) |
|---|---|
| From Literature Based Average[1] Generation Rate | 10 |
| From Task Force Survey Average[1] | 16 |

[1] Based on 20,296 hospital beds. Hospital bed statistics for 1987 supplied by the Ministry of Health, Province of British Columbia.

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# 6.0 BIOMEDICAL WASTE HANDLING, STORAGE, TRANSPORT, TREATMENT AND DISPOSAL

## 6.1 EXISTING SITUATION AND CAPABILITIES IN B.C.

### 6.1.1 Incineration

The existing situation on the incineration of biomedical waste from various sources in B.C. has already been discussed in detail in an earlier chapter. In summary, incineration appears to be a commonly practised method of disposal of biomedical waste in the Province.

Incineration is carried out either on-site or off-site, depending on the size, and location of the institution, as well as on the availability of alternate disposal systems. The incinerators in use are both non-pathological and pathological types, and they are of various makes and ages. The capacity of the units ranges from 20 kg/h to 1300 kg/h, and the average operating period of these units varies from about 1 h/week to 84 h/week. Auxiliary fuel is used in all units, either continuously or intermittently. None of these units is equipped with any air pollution control device, and no energy recovery is practised at any facility. The ash is discharged into landfills.

Only one hospital incinerator and five pathological incinerators are operating under Waste Management Permits, although several operate under bylaws of the local municipal, regional district or other agencies.

The Permit for the hospital waste incinerator stipulates emission limits for particulates, hydrogen chloride and chlorine, as well as the opacity limit, minimum operating temperatures in the primary and secondary chambers, and various operating requirements. Monitoring requirements are for waste charging rate and combustion chamber temperatures.

The Permits for the pathological waste incinerators stipulate emission limits for particulates only. Other requirements prescribed are minimum operating temperatures, opacity and in some cases odour control. Recording of the operating temperature is the only monitoring required in those Permits.

Incinerators operating within the jurisdiction of the Greater Vancouver Regional District have operating Permits which generally stipulate certain operating conditions such as minimum stack gas discharge temperature, waste charging limit, etc. Although no monitoring is required, a temperature indicator for the stack gas is prescribed.

Available emissions data from earlier tests of the incinerator at the Royal Jubilee Hospital in Victoria (Bumbaco, 1983), and recent monitoring of incinerators at four hospitals and one animal clinic in the Greater Vancouver area (Beauchemin, 1988) are presented in Table 6.1. As compared to the emission guidelines listed in Table 6.2, in general both particulates and hydrogen chloride emission levels from these incinerators appear to be above the corresponding limits proposed by several regulatory agencies.

## TABLE 6.1

## EMISSIONS OF CONTAMINANTS FROM HOSPITAL INCINERATORS IN BRITISH COLUMBIA

| Contaminant | Facility | | | | | |
|---|---|---|---|---|---|---|
| | Royal Jubilee Hospital, Victoria[1] | Vancouver General Hospital, Vancouver[2] | St. Mary's Hospital, New Westminister[2] | St. Paul's General Hospital, Vancouver[2] | Delta Hospital, Delta[2] | Vancouver Animal Pound, Vancouver[2] |
| Particulates, mg/m$^3$ | 212 | 224 | 28 - 513* | 104 | | 89 - 159 |
| Hydrogen chloride, mg/m$^3$ | 2018 | 336 | 37 - 66* | 72 | 402 | |
| Cadmium, mg/m$^3$ | 0.21 - 0.42 | | | | | |
| Chromium, mg/m$^3$ | 0.14 - 0.25 | | | | | |
| Copper, mg/m$^3$ | 0.41 - 0.94 | | | | | |
| Lead, mg/m$^3$ | 5.48 - 5.54 | | | | | |
| Manganese, mg/m$^3$ | 0.10 - 0.16 | | | | | |
| Mercury, mg/m$^3$ | 0.003 - 0.003 | | | | | |
| Nickel, mg/m$^3$ | 0.05 - 0.06 | | | | | |
| Zinc, mg/m$^3$ | 11.36 - 15.67 | | | | | |
| Total PCDDs, ng/m$^3$ | 268 | | | | | |
| Total PCDFs, ng/m$^3$ | 605 | | | | | |

[1]. Corrected to 12% $CO_2$

[2]. Corrected to 12% $CO_2$ where data available

* May have been burning paper only.

(Bumbaco, 1983; Beauchemin, 1988)

## SUMMARY OF HOSPITAL WASTE INCINERATOR EMISSION REGULATIONS*

| Jurisdiction | Unit Capacity (kg/h) | Contaminant (mg/m³) | | | | |
|---|---|---|---|---|---|---|
| | | Particulates | Hydrogen chloride | Carbon monoxide | Sulphur dioxide | Opacity |
| Connecticut | | 46 (@12%$CO_2$) | | | | |
| Illinois | <907 | 230 - 460 (@12%$CO_2$) | | | | 30% |
| | >907 <2724 | 184 (@12%$CO_2$) | | | | 30% |
| | >2724 | 115 (@12%$CO_2$) | | | | 30% |
| New Jersey | | 46 (@12%$CO_2$) | | | | |
| New York¹ | | 35 (@7%$O_2$) | 76 or 90% reduction | 116 (1-h avg. @7% $O_2$) | | Less than 10% during any 6-minute period, except a max. of one 6-minute period/hour of less than 20% |
| Pennsylvania¹ | >227 | 184 (@7% $O_2$) | <1.8 kg/h or 90% reduction by weight on an hourly basis | 116 (1-h avg. @7% $O_2$) | | Less than 10% for a period or an aggregated period of 3 minutes/hour, or less than 30% at any time |
| | >227 <907 | 69 (@7% $O_2$) | 46 (1-h avg. @7% $O_2$) or 90% reduction by weight on an hourly basis | 116 (1-h avg. @7% $O_2$) | 80 (1-h avg. @7% $O_2$) or 75% reduction by weight (8-h avg.) | Less than 10% for a period or an aggregated period of 3 minutes/hour, or less than 30% at any time |
| | >907 | 35 (@ 7% $O_2$) | 46 (1-h avg. @ 7% $O_2$) or 90% reduction by weight on an hourly basis | 116 (1-h avg. @7% $O_2$) | 80 (1-h avg. @ 7% $O_2$) 75% reduction by weight (8-h avg.) | Less than 10% for a period or an aggregated period of 3 minutes/hour, or less than 30% at any time |
| Tennessee¹ | | 230 (@ 12% $CO_2$) | 70 (24-h avg.) | | | Less than 10% (6-minute avg.), except for one 6-minute period/hour of less than 20% |
| European (unnamed) | | 200 (@ 7% $CO_2$) | 300 (@ 7% $CO_2$) | 500 (@ 7% $CO_2$) | 200 (@ 7% $CO_2$) | Not to exceed 30% |

*Most jurisdictions also have various requirements for incinerator design, operation and monitoring. Minimum combustion chamber temperature and residence time for gases are specified in most cases. Several regulations require continuous monitoring of combustion parameters and hydrogen chloride.

State of Pennsylvania requires an extensive source testing for various contaminants including trace elements and trace organics at least once a year or as prescribed by the Department.

¹. Proposed draft regulations.

(US EPA, 1987; New York, 1988; Pennsylvania, 1986; Tennessee, 1988)

Ash and Residue Characteristics

The ash analysis data from two hospital waste incinerators are shown in Table 6.3. The incinerator at the Royal Jubilee Hospital in Victoria, B.C. is equipped with a heat exchanger but no pollution control equipment. Both bottom ash and fly ash samples were analysed for dioxins and furans (Bumbaco, 1983). Another set of data in Table 6.3 is from a hospital incinerator in Los Angeles, California, which is equipped with fabric filters to control particulates emission. Ash samples were analysed for several trace metals as well as dioxins and furans (Jenkins, 1987). The enrichment of fly ash with trace contaminants is clearly evident from these data.

### 6.1.2 Non-Incineration Technologies

Existing practices for handling biomedical wastes were identified through the Task Force questionnaire survey and the results can be summarized as follows:

Health Care Centres

Practices vary in accordance with the urban or rural setting of the facility. About half of the responding hospitals, within the GVRD, landfill a range of biomedical waste components from all of it to only liquid human anatomical, infectious microbiologicals pretreated by autoclave or chemicals or non-infectious fractions. Discharge to sewer is universally used for human biological wastes and to some extent, for pretreated human liquid anatomical and laboratory chemical wastes. Those hospitals which employ a commercial hauler for off-site disposal mostly use the system for sharps, pathological, laboratory and chemotherapy wastes although one hospital uses the carrier exclusively for all its biomedical waste.

In other major urban areas, except Greater Victoria where total incineration is used, landfill was reported in some instances for disposal of pretreated sharps and microbiologicals. In smaller communities, minor percentages of biomedical wastes in all categories, except antineoplastics and radioactive substances, were reported to be sewered and landfilled.

With regard to the status of biomedical waste pretreatment prior to disposal, there is no readily discernable common approach. More than half of all hospitals surveyed use bleach or autoclaving predominantly for pretreatment. Most commonly, laboratory microbiologicals, sharps and blood products are pretreated.

The survey revealed that segregation of wastes is performed by most hospitals by colour coding, labels and specialized containers.

Veterinary Centres

Except for freezing and separate transportation of animal carcasses, all biomedical wastes not destined for incineration is collected as part of the municipal waste stream without pretreatment. Biological waste is sewered.

General Physicians

Sharps are sometimes specially packaged for incineration. Drugs, liquid anatomical and biologicals are sewered and the remainder of the wastes are discharged as general refuse. One clinic reported chlorinating blood products prior to disposal.

## TABLE 6.3

## ANALYSIS OF ASH SAMPLES FROM HOSPITAL INCINERATORS

| Facility | Ash Sample Type | Contaminants | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Trace Organics (ng/g) | | Trace Metals (µg/g) | | | | | | |
| | | Total | Total | Arsenic | Cadmium | Chromium | Iron | Lead | Manganese | Nickel |
| Royal Jubilee Hospital, Victoria, BC | Fly ash (A) | 259.1 | 297.5 | | | | | | | |
| | Fly ash (B) | 6477.9 | 5868.5 | | | | | | | |
| | Bottom ash from various locations on the hearth | 1.6 - 2.7 | 3.6 - 11.2 | | | | | | | |
| Cedars-Sinai Medical Centre, Los Angeles, California | Fly ash (Baghouse) | 114 | 141 | 4.7 | 1665.6 | 1.0 | 3107.1 | 89.3 | 242.5 | 33.3 |
| | Bottom ash | <0.26 | <0.22 | 0.7 | 2.8 | 0.7 | 17443 | 1654.8 | 227.0 | 33.1 |

* Total of tetra-, penta-, hexa-, hepta- and octa- homologue concentrations.

(A) Fly ash collected from the walls of the duct leading from the heat exchanger to the low temp stack.
(B) Fly ash collected from the bottom of the duct leading from the heat exchanger to the low temp stack.

(Bumbaco, 1983; Jenkins, 1987)

Dentists

Apart from scrap amalagams being returned for re-smelting, all other wastes are discharged to the municipal stream. Commonly, sharps are containerized before disposal. Liquids are sewered.

University Animal Care Facilities and Research Laboratories

As indicated in Chapter 4.0 universities in the Province are currently disposing of infectious and non-infectious animal solid wastes by incineration and landfilling. Waste sharps generated by these institutes are being disposed of by both on-site and off-site incineration, while liquid wastes from infectious and non-infectious animals are currently being sewered; however, pretreatment status of these wastes differs between institutions. University "C" currently autoclaves or sterilizes all microbiological wastes prior to having these wastes landfilled; University "A" and University "B" did not identify these wastes in their questionnaires.

## 6.2 TECHNOLOGIES FOR POSSIBLE APPLICATION TO B.C.

### 6.2.1 Handling, Storage and Transport Technologies

A number of technologies and recommendations for the handling, storage and transport of biomedical wastes are described in the literature. Environment Canada has previously reviewed and included a section on the best available management technologies for biomedical wastes in its report on biomedical wastes (Environment Canada, 1988). The pertinent sections of the Environment Canada report applicable to the handling, storage and transport of biomedical wastes are given in Appendix 6.1.

### 6.2.2 Incineration

An overview of the incineration technology applicable to biomedical waste appears in Appendix 6.2. Since biomedical waste incinerator operating data are uncommon, this appendix deals primarily with small municipal waste incinerators, because of the similarities in their features. Various aspects of waste incineration discussed in Appendix 6.2 are as follows:

- combustion process
- waste characteristics - physical, chemical and microbiological
- incinerator types - multiple-chamber, controlled air and rotary kiln
- pollution aspects of incineration
- emission characteristics, control and control costs
- energy recovery potential
- emission regulations and strategies

B.C. Special Waste Services Inc.

The selection of B.C. Special Waste Services Inc. as the operator of the Province's special waste facility may present an additional option for the management of biomedical wastes. The facility is to be an integrated system equipped with a modular rotary kiln, which would be technically capable of incinerating biomedical wastes. (The technical capabilities of rotary kilns is discussed in Appendix 6.2.) Final disposal of ash residues from special waste incineration will be in a secure landfill that is to be part of the from special waste incineration will be in a secure landfill that is to be part of the facility. This company is interested in the possibility of disposing of biomedical wastes in their special waste management system, using regional collection facilities to be located throughout the Province.

Burnaby Municipal Waste Incinerator

The new Burnaby municipal incinerator is equipped with state-of-the-art air emission control equipment which would properly treat gases from the combustion of biomedical wastes. However, at the present time the Burnaby facility is not under permit for the burning of biomedical wastes.

### 6.2.3 Biomedical Waste Treatment Technologies

The following list of biomedical waste treatment options, differing in their stage of development between experimental and demonstrated technology, were reviewed for their potential application to selected categories of the biomedical waste stream:

- sterilization by steam (autoclave)
- sterilization by dry heat
- sterilization by chemical vapour
- sterilization by irradiation
- physical/chemical treatment

A full discussion of these treatment methods is available in Appendix 6.3.

Since these treatment processes are non-destructive, they must be accompanied by satisfactory disposal techniques. For the purpose of this section only the applicability of landfill and sanitary sewer as ultimate disposal alternatives were considered, since incineration is addressed in the preceding section.

The extent to which the discharge of biomedical waste poses a threat to the general environment is unclear. The Task Force found little evidence on biomedical wastes' hazards, fate and impacts on human health and the environment when disposed of in sewer systems or sanitary landfills, . Unquestionably, there is concern for the potential hazards presented in the handling and processing of biomedical wastes, so that the more direct is the disposal mechanism, possibly the less critical is the need for pre-discharge treatment of some waste categories.

### 6.2.4 Transfer Stations

At the present time the GVRD uses two waste transfer stations for the compaction of domestic refuse before incineration or landfilling. Wastech Services Ltd. operates these two facilities under contract to the GVRD. Current contractual agreements between the two parties excludes the handling of biomedical wastes at these facilities; however, as was discussed in Chapter 3.0, biomedical wastes have continued to be disposed of with the regular refuse stream and as a result continue to arrive at the transfer stations.

The City of Vancouver will be bringing on-line its own transfer station in mid-February. This facility will, like the GVRD's facilities, compact refuse prior to the wastes being sent to landfill. The City of Vancouver is also planning to construct a combined resource recovery plant and transfer station that will use manual segregation to remove recyclable materials from the waste stream. As has been experienced at the

GVRD transfer stations, biomedical wastes arriving at these facilities could be perceived as posing an unacceptable hazard to workers and the public.

### 6.2.5 Central Disposal Facilities

As an alternative to individual generators meeting their own biomedical waste disposal requirements, it may be practical to develop central or regional disposal facilities for biomedical wastes.

With the implementation of such a strategy, biomedical wastes could be collected from individual generators or from strategically located regional collection depots and be transported off-site to a centralized facility for their treatment and/or disposal.

A central disposal facility could incorporate a number of technologies suitable for the treatment and disposal of biomedical wastes including, large incinerators equipped with state-of-the-art pollution control equipment, autoclaves and grinding/treatment units. A discussion of these technologies is provided in Appendix 6.2 and Appendix 6.3.

Several jurisdictions, including Metropolitan Toronto, are considering large-scale facilities to manage biomedical wastes from major population areas, using technologies such as large incinerators, autoclaves and waste grinding/treatment operations. A discussion of activities from other jurisdictions is provided in Appendix 6.4.

### 6.2.6 Small Quantity Biomedical Waste Management Programs

A number of jurisdictions have met with some success in managing biomedical wastes from sources typically considered "small quantity" generators.

In Alberta, the Alberta Pharmaceutical Association has initiated the "Great Drug Roundup," which was held in May, 1988, and encouraged the public to drop off outdated drugs at one of over 600 pharmacies. The Alberta Special Waste Management System provided containers for the drugs which were collected and transported to the Alberta Special Waste Treatment Centre for treatment and disposal. Costs for transport treatment and disposal were absorbed by the Alberta Special Waste Management Centre. A similar roundup held in Edmonton in 1987, yielded 1365 litres of old medicine (Collections, 1988).

The town of Braintree, Maryland has initiated, under the direction of the town's health director, a disposal day for the collection of infectious wastes. The collection day was seen as a means of preventing illegal or improper disposal of these wastes. A single day of collection netted more than 100 pounds of infectious wastes from local doctors, morticians, nursing homes and dentists. The materials collected included needles, tainted vials, pieces of soiled gauze and garments. All materials were disposed of by incineration (Infectious Waste News, 1987a). The town's Board of Health has also suggested the use of night depositories for syringe and needle disposal, in an effort to help protect refuse workers from needle sticks from residential refuse. In 1987 alone, syringes and needles in residential refuse injured four Braintree refuse workers (Infectious Waste News, 1987b).

## 6.3 BIOMEDICAL WASTE COMPANIES OPERATING IN THE PROVINCE OR SERVING THE PROVINCE

As evident from survey results presented earlier, off-site incineration is practised by various generators of biomedical waste in the Province to dispose of either a part or all of the waste generated. Off-site facilities include an incinerator at another nearby hospital, a municipal waste incinerator, a hog fuel burner at local forest products company, and an out-of-country biomedical waste incinerator. There is only one known specialized biomedical waste haulage company, BFI Medical Waste Systems, operating in British Columbia at present.

BFI Medical Waste Systems is currently handling the disposal of biomedical wastes for Lions Gate, B.C. Cancer Control, Maple Ridge and Mount St. Joseph hospitals in the Lower Mainland. St. Paul's Hospital has contracted BFI for the disposal of sharps and the Vancouver Branch of the Red Cross is using BFI for its disposal requirements. The survey results also indicate that this kind of contract with BFI is currently being considered by a number of other hospitals in the Greater Vancouver, Lower Fraser Valley and Vancouver Island areas. Wastech Services Ltd. has also contracted with BFI for the cleanup and disposal of biomedical wastes arriving at their facilities. At present BFI Medical Waste Systems handles 2 tonnes per week of biomedical wastes and transports wastes for disposal to the Thermal Reduction Disposal facility in Bellingham, Washington.

BFI provides their customers with all the packaging and containment requirements for the safe handling, storage and transport of biomedical wastes. The colour coding used for bags and labels used is taken from the recommendations of the draft US EPA report on Infectious Wastes. BFI only handles the transport of materials that are properly packaged and sealed and does not handle any bulk liquids transport. BFI is currently assessing the capabilities for a Province-wide biomedical waste collection network (B.C. Task Force on Biomedical Waste Management, February 1988).

## 6.4 DISCUSSION

### Incineration Technologies

Incineration appears to be an appropriate technology for the disposal of biomedical waste alone or mixed with other hospital refuse, provided the equipment is designed and operated properly. However, it is not very suitable for some liquids such as blood and blood products. To ensure destruction of microorganisms present in the infectious portion of these wastes, provisions must be made for the waste to be exposed for an adequate duration at a sufficiently high temperature.

Despite the effectiveness of incineration in disposing of these wastes, there is an increasing concern over the characteristics of certain contaminants emitted from these incinerators. The contaminants of primary concern are acid gases, mainly hydrogen chloride, trace metals and trace organics, particularly toxic halogenated hydrocarbons. The waste generated at hospitals contains metals and chlorinated plastics, which contribute to the formation of these contaminants.

Although there is very little information in the literature on the characteristics of emissions from incineration of hospital waste, the concern stems from the current knowledge about the presence of certain contaminants in the flue gases from municipal waste incinerators. Both hospital waste and municipal waste contain metals and chlorinated plastics, the precursor of hydrogen chloride and trace halogenated organics. The total plastic content in the former type of waste is reportedly much higher than that in the latter type.

The emission levels of contaminants can be controlled by a number of measures, including the installation of flue gas treatment equipment. There are efficient proven technologies for the removal of acid gases, particulates, and fine particles enriched with trace metals and trace organics. However, the cost of control equipment will depend on the type of technology, contaminants to be removed, and the level of their removal. For small capacity incinerators usually installed for hospital waste, the cost of the best available control technology, dry scrubber and fabric filter system, is very high relative to the incinerator cost. In general, the relative cost of pollution control becomes lower as the incinerator capacity increases. Accordingly, a large unit equipped with emission control system is preferable to a number of small incinerators. Any recovery of potential energy from the incinerator flue gas is also cost-effective with a large unit, and any cost savings from energy utilization would be beneficial to the overall economy of the facility.

Depending on the emission control technology used, both wastewater and solid waste may be generated at the site, and these may require treatment or special handling. Not much information is available on the characteristics of such waste streams, but it is likely that fly ash properties may be of some concern.

Recognizing both the prevalence of incineration as a common method of disposal of biomedical waste and the environmental concerns associated with such practice, the following needs have been identified.

- guidelines for emission of contaminants from biomedical waste incinerators on the basis of best available equipment and emission control technology to minimize environmental risks;
- minimum design, operational and monitoring requirements for biomedical waste incinerators;
- training requirements for incinerator operators in the Province;
- characterization of the properties of ash and other residues generated in the incinerator and its pollution control equipment, and recommended methods of handling and disposal of these materials;
- guidelines for effluent discharges from incineration facilities;
- information on the potential impacts of incinerating biomedical waste in municipal waste incinerators.

### Packaging, Labelling, and Storage

The Task Force has observed a range of biomedical waste segregation, packaging, labelling, and storage practices in British Columbia. A major concern is that biomedical wastes are not properly segregated from the municipal waste stream, and that packaging and labelling are not always adequate. Secure storage or biomedical wastes is also not always provided.

### Transfer Stations

The use of waste Transfer Stations for biomedical wastes requires some consideration. On one hand, it may be simplest to avoid using transfer stations for biomedical wastes completely, and have the waste transported directly to the ultimate site of treatment and/or disposal. This will remove the potential for public and worker exposure to biomedical wastes at transfer stations.

On the other hand, it is possible that there is no need to eliminate the use of transfer stations for all biomedical waste streams. Transfer stations could continue to receive these wastes provided that they function only as collection or staging areas, and that the wastes would not be compacted, in order to preserve the integrity of packaging. Biomedical wastes could be transported in dedicated loads to transfer stations at regular or pre-arranged times for processing in secure areas of the facility. For this to work well, biomedical wastes need to be properly segregated at source and care exercised to ensure that biomedical wastes such as sharps and human anatomical wastes are not sent to these facilities. In addition, generators, the public and waste management staff must be adequately trained and educated on the hazards of biomedical wastes.

If transfer stations are to function as staging areas for biomedical wastes, it may be necessary to install specialized equipment to ensure that proper storage requirements are met and to have operators of these facilities develop contingency plans to handle possible spills. Additionally, such facilities may require permits from the Ministry of Environment.

### Pretreatment

The decision to use sterilization or disinfection to pretreat biomedical waste before disposal to a large extent depends on the disposal option chosen, and this will be discussed in detail in the sections below on sanitary landfill and sanitary sewer disposal. The Task Force found little evidence that indicated either sterilization or disinfection would be preferred methods of treatment before disposal to sewer or landfill, except in the case of infectious microbiological waste, which is normally expected to be highly infectious, and thus, should be sterilized.

### Central Disposal Facilities

Because of the potential to minimize costs through economies of scale with large, central biomedical waste facilities, a number of stakeholders have approached the Task Force with questions and comments on this subject. There are a number of issues that need to be addressed before such facilities are established, including roles and responsibilities of the public and private sectors regarding facility operation and ownership; the size of the area served; and the most suitable technologies to use. It is interesting that the preliminary choice of a central technology in Toronto is a grinding/treatment system rather than incineration (Hospital Council of Metropolitan Toronto, 1986).

### Sanitary Landfill Disposal

The Task Force, in considering the suitability of sanitary landfilling as an option for biomedical waste disposal, has reviewed the requirements for each biomedical waste category, particularly from the standpoint of waste pretreatment and human health and environmental impacts. The results of this review are contained in a proposal shown in

Table 6.4, and the following summarizes the rationale underlying the choices made in this table:

- Solid human anatomical waste - not suitable for aesthetic reasons
- Liquid human anatomical waste - not suitable for pure liquids; sanitary landfills are for solid wastes
- Infectious animal waste - special biomedical waste should be sterilized or disinfected before landfilling; solids, but not liquids are acceptable in landfills
- Infectious biological waste - special biomedical waste should be sterilized or disinfected before landfilling; liquids are not acceptable in solid waste landfills
- Infectious non-anatomical waste - special biomedical waste should be sterilized or disinfected before landfilling
- Waste sharps - must be pretreated and rendered non-sharp, or immobilized before landfilling
- Infectious microbiological waste - this waste can be highly infectious and requires sterilization; pretreated solids may be landfilled
- Chemicals and pharmaceutical wastes - must be handled as special wastes

These choices assume that disposal of the waste is permitted under Provincial and local laws and bylaws.

### Sanitary Sewer Disposal

The Task Force carried out a similar review for sanitary sewer disposal requirements, and the results are contained in a proposal shown in Table 6.5 The following comments provide a rationale for these choices:

- Solid human anatomical waste - not suitable for aesthetic reasons; sewers are not designed for solids
- Liquid human anatomical waste - currently disposed of to sanitary sewer without apparent adverse impact
- Infectious animal waste - currently disposed of to sanitary sewer without apparent adverse impact; solids are not appropriate in sewer systems
- Infectious biological waste - currently disposed of to sanitary sewer without apparent adverse impact
- Infectious non-anatomical waste - sanitary sewers not intended for solids

## TABLE 6.4

## PROPOSAL:

## CATEGORIES OF BIOMEDICAL WASTE THAT MAY ACCEPTABLY BE DISPOSED OF IN PERMITTED SANITARY LANDFILLS

| Waste Category | Biomedical Waste Pretreatment Status | |
|---|---|---|
| | Pretreated | Not Pretreated |
| 1. Solid human anatomical waste | unsuitable[1] | unsuitable |
| 2. Liquid human anatomical waste | unsuitable | unsuitable |
| 3. Infectious animal waste (solid) | acceptable[2,3] | unsuitable |
| 4. Infectious biological waste (solid) | acceptable[3] | unsuitable |
| 5. Infectious non-anatomical waste (solid) | acceptable[3] | unsuitable |
| 6. Waste sharps | acceptable[4] | unsuitable |
| 7. Infectious microbiological waste (solid) | acceptable[5] | unsuitable |
| 8. Chemical and pharmaceutical wastes | unsuitable | unsuitable |

[1] Unsuitable means the option is not appropriate from the standpoint of aesthetics, public health or the environment; the waste is liquid; or that the waste should be pretreated by sterilization or disinfection.

[2] Acceptable means sanitary landfill disposal is one of the methods that could be used to dispose of the waste stream properly from a public health and environmental prospective.

[3] Solid infectious biomedical wastes may be landfilled if they are pretreated by sterilization or disinfection.

[4] Sharps that have been 1) blunted or ground and then disinfected or sterilized, or 2) solidified, may be landfilled.

[5] Sterilization is the preferred method of pretreatment.

## TABLE 6.5

## PROPOSAL:

## CATEGORIES OF BIOMEDICAL WASTE THAT MAY ACCEPTABLY BE DISPOSED OF IN SANITARY SEWER SYSTEMS

| Waste Category | Biomedical Waste Pretreatment Status | |
|---|---|---|
| | Pretreated | Not Pretreated |
| 1. Solid human anatomical waste | unsuitable[1] | unsuitable |
| 2. Liquid human anatomical waste | acceptable | acceptable[2,3] |
| 3. Infectious animal waste (liquid) | acceptable | acceptable[3] |
| 4. Infectious biological waste (liquid) | acceptable | acceptable[3] |
| 5. Infectious non-anatomical waste (liquid) | unsuitable | unsuitable |
| 6. Waste sharps | unsuitable[4] | unsuitable |
| 7. Infectious microbiological waste (liquid) | acceptable[5] | unsuitable |
| 8. Chemical and pharmaceutical wastes | unsuitable | unsuitable |

[1] Unsuitable means the option is not appropriate from the standpoint of aesthetics, public health or the environment; the waste is solid; or that the waste should be pretreated before disposal by sterilization or disinfection.

[2] Acceptable means sanitary sewer disposal is one of the methods that could be used to dispose of the waste stream properly from a public health and environmental perspective.

[3] Liquid infectious biomedical waste must be sterilized or disinfected before disposal to a sanitary sewer, with the exception of liquid isolation wastes and non-AIDs contaminated blood and blood products.

[4] Liquids from ground and disinfected sharps may be disposed of in sanitary sewer.

[5] Sterilization is the preferred pretreatment option.

- Waste sharps - sanitary sewers not intended for solids
- Infectious microbiological waste - this waste can be highly infectious and requires sterilization; liquids may be disposed of after sterilization
- Chemicals and pharmaceutical wastes - must be treated as special wastes

These choices presume that the disposal of the waste by sanitary sewer is legally permitted.

## 6.5 REFERENCES

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# 7.0 LEGISLATIVE AND REGULATORY BIOMEDICAL WASTE CONTROLS

## 7.1 CANADIAN INITIATIVES

In Canada there is currently no single comprehensive piece of legislation for the management of biomedical wastes at either the Federal or Provincial regulatory levels.

Management of biomedical wastes, like other waste streams, is a Provincial regulatory responsibility; however, the Federal Government provides controls for some biomedical wastes under the following Federal Statutes:

- Animal Disease and Protection Act
- Fisheries Act
- Transportation of Dangerous Goods Act

At the present time Ontario is the only Province with specific legislation for the management of some biomedical wastes; "pathological wastes" are included in the Province's Environmental Protection Act. Other Provinces such as Manitoba, Alberta and British Columbia include "infectious wastes" in Provincial regulations through the adoption of the Federal Transportation of Dangerous Goods Act. Quebec is currently assessing the necessity to include biomedical wastes under the Hazardous Waste Regulations of the Environmental Quality Act.

For the most part, the disposal of biomedical wastes at sanitary landfills and into the sewer system remains under municipal regulatory responsibility.

Reviews of Federal, Provincial and Municipal legislation providing for the management of biomedical wastes in Canada are given in Appendix 7.1.

## 7.2 AMERICAN INITIATIVES

### 7.2.1 Federal Regulations

To date no single U.S. Federal authority has assumed the lead role in establishing a comprehensive set of federal regulations addressing biomedical waste management or biomedical waste disposal.

The U.S. Department of Transportation and the Occupational Safety and Health Administration have promulgated regulations for the packaging and labelling of "biohazardous" materials (ie. those containing etiological agents). Under these regulations generators and transporters of such wastes must observe minimum Federal requirements in all States.

The U.S. Senate and House of Representatives have introduced several Bills in the past year that would amend the Solid Waste Disposal Act, administered by the US EPA to address the issue of biomedical wastes. Summaries of the proposed Bills related to biomedical wastes are provided in Section 7.2.1 of Appendix 7.2. A general review of the American legislative initiatives for biomedical wastes appears in Appendices 7.2 - 7.6.

### 7.2.2 State Regulations

#### 7.2.2.1 National Solid Waste Management Association Survey

The National Solid Waste Management Association (NSWMA) has recently completed a survey of infectious waste regulations in the United States as of October, 1987. A summary of their findings is given in Figure 7.1 (DeCastro, 1988).

A discussion of the NSWMA's findings is provided in Section 7.2.2.1 of Appendix 7.2.

#### 7.2.2.2 B.C. Biomedical Task Force Survey of U.S. Legislation For Biomedical Wastes

In response to the April, 1987 request to various American state agencies for information on existing or pending legislation for biomedical waste, responses from 33 states and two U.S. Counties were received.

Responses were reviewed to assess the following requirements of State and County legislation:

- existence of legislation addressing biomedical wastes
- administrator of legislation
- whether biomedical wastes are defined under the legislation
- applicability of legislation
- exemptions from regulations
- handling, storage and packaging requirements
- treatment and disposal requirements
- transportation requirements for biomedical waste shipments

A summary of these findings is given in Tables 7.1, 7.2, 7.3 and 7.4, with a more comprehensive discussion of these findings provided in Section 7.2.2.2 of Appendix 7.2.

### 7.2.3 County Legislation

A summary of legislation from Anchorage, Alaska, Marion County, Indiana and Seattle-King County, Washington is given in Tables 7.1, 7.2, 7.3 and 7.4 and discussed in greater detail in Section 7.2.3 of Appendix 7.2.

## 7.3 EUROPEAN INITIATIVES

A review of available literature failed to turn up information on current legislation in European countries for the management of biomedical wastes. Reference to some European legislation pertaining to biomedical wastes were included in Recycling International (Thomé-Kozminsky, 1982); however, legislation cited was only partial and generally preceded 1981; some dated to 1932. As such, since the purpose of such a review was to reflect current legislative trends for the management of biomedical wastes no comments on European initiatives can be included.

FIGURE 7.1 NSWMA INFECTIOUS WASTE SURVEY, OCTOBER, 1987

| | AL | AK | AZ | AR | CA | CO | CT | DE | DC | FL | GA¹ | HI | ID | IL | IN | IA | KS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ▶ Does your state regulate infectious wastes in some way? | Y | N | Y | Y | Y | Y | N | N | N | Y | N | Y | Y | Y | Y | Y | Y |
| ▶ Does your state have a legal definition of what constitutes an infectious waste stream? | N | N | Y | Y | Y | N | N | N | N | Y | N | Y | Y | Y | Y | N | Y |
| ▶ Which of the following treatments does your state REQuire or RECommend prior to landfilling? | | | | | | | | | | | | | | | | | |
| Autoclaving | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | REQ |
| Incineration | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | REC |
| Either | REQ | REC | REQ | REQ | REQ | REQ | REC | REC | REC | REQ | REC | REQ | REQ | REQ | REQ | REQ | . |
| ▶ Does your state regulate infectious waste as a hazardous waste? | N | N | N | Y | Y | N | N | N | N | N | N | N | N | Y | Y | N | N |
| ▶ Does your state impose hospital infectious waste regulations on other generators? | N | N | Y | N | Y | N | N | N | N | N | N | N | N | N | N | Y | Y |
| ▶ Does your state regulate the transportation of untreated infectious wastes? | N | N | Y | N | Y | N | N | N | N | N | N | N | N | N | Y | N | N |
| ▶ Is your state expecting infectious waste legislation or regulations in the next year? | N | N | N | N | N² | N | Y | Y | Y | Y | N | N | Y | N | Y | N | N |

¹ Only the GA Department of Human Resources responded to the survey. The Department of Natural Resources chose not to respond.

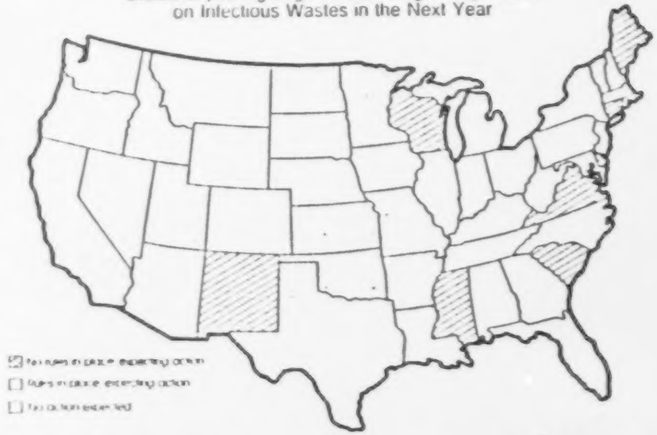
² Neither incineration nor autoclaving are required except for infectious body parts and waste cultures. All other infectious wastes may go to a sanitary landfill.

| | KY | LA | ME | MD | MA | MI | MN | MS | MO | MT | NE | NV | NH | NJ | NM | NY | NC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ▶ Does your state regulate infectious wastes in some way? | Y | Y | N | Y | Y | N | Y | N | Y | N | Y | Y | Y | Y | N | Y | Y |
| ▶ Does your state have a legal definition of what constitutes an infectious waste stream? | Y | Y | N | Y | Y | N | Y | N | Y | N | Y | Y | Y | Y | N | Y | Y |
| ▶ Which of the following treatments does your state REQuire or RECommend prior to landfilling? | | | | | | | | | | | | | | | | | |
| Autoclaving | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Incineration | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Either | REQ | REC | REC | REQ | REQ | REC | REQ | REC | REQ | REC | REQ | REC | REQ | REQ | REC | REQ | REQ |
| ▶ Does your state regulate infectious waste as a hazardous waste? | N | N | N | N | N | N | N | N | Y | N | N | N | N | N | N | N | N |
| ▶ Does your state impose hospital infectious waste regulations on other generators? | Y | N | N | Y | Y | N | Y | N | Y | N | N | N | Y | Y | N | N | Y |
| ▶ Does your state regulate the transportation of untreated infectious wastes? | N | N | N | Y | Y | Y | Y | N | Y | N | N | N | Y | N | N | Y | N |
| ▶ Is your state expecting infectious waste legislation or regulations in the next year? | N | Y | Y | Y | N | N | Y | Y | Y | N | Y | N | N | Y | Y | Y | N |

| | ND | OH | OK | OR | PA | RI | SC | SD | TN | TX | UT | VT | VA | WA | WV | WI | WY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ▶ Does your state regulate infectious wastes in some way? | Y | N | N | Y | Y | Y | N | N | Y | Y | N | Y | N | N | Y | N | N |
| ▶ Does your state have a legal definition of what constitutes an infectious waste stream? | Y | N | N | N | Y | Y | N | N | Y | Y | N | Y | N | N | Y | N | N |
| ▶ Which of the following treatments does your state REQuire or RECommend prior to landfilling? | | | | | | | | | | | | | | | | | |
| Autoclaving | . | . | . | . | . | . | . | . | . | . | . | . | REC | . | . | . | . |
| Incineration | . | . | . | . | . | . | . | . | . | REQ³ | . | . | . | . | . | . | . |
| Either | REQ | REC | REC | REQ | REQ | REQ | REC | REC | REQ | . | REC | REQ | . | REC | REC | REC | REC |
| ▶ Does your state regulate infectious waste as a hazardous waste? | N | N | N | N | N | Y | N | N | N | N | N | Y | N | N | N | N | N |
| ▶ Does your state impose hospital infectious waste regulations on other generators? | Y | N | N | N | Y | Y | N | N | N | Y | N | N | N | N | N | N | N |
| ▶ Does your state regulate the transportation of untreated infectious wastes? | Y | N | N | Y | Y | Y | N | N | N | N | N | Y | N | N | Y | N | N |
| ▶ Is your state expecting infectious waste legislation or regulations in the next year? | N | N | N | Y | Y | Y | Y | N | Y | Y | N | Y | Y | N | Y | Y | N |

³ Hospital licensure rules say that only infectious body parts require incineration.

States Expecting Legislative or Regulatory Action on Infectious Wastes in the Next Year


☑ No rules in place expecting action
☐ Rules in place expecting action
☐ No action expected

(De Castro, 1988)

TABLE 7.1

## B.C. BIOMEDICAL TASK FORCE SURVEY RESULTS SUMMARY OF AMERICAN LEGISLATION FOR BIOMEDICAL WASTES

| | No. of States* With | No. of States* Without | No. of States* Not Addressing | No. of Counties** With | No. of Counties** Without | No. of Countries** Not Addressing |
|---|---|---|---|---|---|---|
| Are there State Regulations for Infectious Wastes? | 25 | 4 | 0 | 2 | 0 | 0 |
| Is there a definition of Infectious Wastes? | 18 | 10 | 1 | 1 | 1 | 0 |
| Is there any small quantity exemption for infectious waste generators? | 5 | 23 | 1 | 0 | 2 | 0 |
| Are generators other than hospitals required to comply with regulations or guidelines? | 20 | 8 | 1 | 2 | 0 | 0 |
| Are wastes required to be segregated at the point of origin? | 12 | 10 | 7 | 2 | 0 | 0 |
| Do regulations/guidelines address on-site storage requirements? | 19 | 6 | 4 | 2 | 0 | 0 |
| Are Infectious Wastes other than sharps subject to special handling requirements? | 19 | 6 | 4 | 2 | 0 | 0 |
| Are sharps required to be contained in puncture-proof containers or otherwise contained? | 21 | 5 | 3 | 2 | 0 | 0 |
| Are Infectious Wastes required to be treated or disposed of on-site? | 3 | 22 | 4 | 0 | 2 | 0 |
| Are shipments of Infectious Wastes to off-site treatment or disposal facilities required to be manifested? | 10 | 10 | 6 | 0 | 2 | 2 |
| Are transporters of infectious waste required to be licensed or registered? | 8 | 12 | 6 | 0 | 2 | 0 |

* Out of 29 states

** Out of 2 counties

TABLE 7.2

## SUMMARY OF RECOGNIZED CATEGORIES OF BIOMEDICAL WASTE INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Biomedical Waste Category | Examples | No. of States | No. of Counties** |
|---|---|---|---|
| Isolation wastes | • refer to Centers for Disease Control (CDC), Guidelines for Isolation Precautions in Hospitals, July 1983 | 17 | 1 |
| Cultures and stocks of infectious agents and associated biologicals | • specimens from medical and pathology laboratories | 13 | 1 |
| | • cultures and stocks of infectious agents from clinical, research, and industrial laboratories; disposable culture dishes, and devices used to transfer, inoculate and mix cultures | 16 | 2 |
| | • wastes from production of biologicals | 10 | 2 |
| | • discarded live and attenuated vaccines | 9 | 2 |
| Human blood and blood products | • waste blood, serum, plasma, and blood products | 12 | 2 |
| Pathological waste | • tissues, organs, body parts, blood and body fluids removed during surgery, autopsy, and biopsy | 19 | 2 |
| Sharps | • Hypodermic needles, syringes, scalpel blades, pasteur pipettes, and broken glass | 16 | 2 |
| Contaminated animal carcasses, body parts and bedding | • contaminated animal carcasses, body parts, and bedding of animals intentionally exposed to pathogens | 16 | 2 |
| Surgery and autopsy wastes | • soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves | 13 | 2 |
| Miscellaneous laboratory wastes | • specimen containers, slides, and cover slips; disposable gloves, lab coats, and aprons | 12 | 2 |
| Dialysis unit wastes | • tubing, filters, disposable sheets towels, gloves, aprons, and lab coats | 9 | 1 |
| Contaminated equipment | • equipment used in patient care, medical laboratories, research, and in the production and testing of certain pharmaceuticals | 8 | 1 |
| Other | | | |

* Out of 25 states

** Out of 3 counties

## TABLE 7.3: SUMMARY OF RECOGNIZED GENERATORS OF BIOMEDICAL WASTES AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Generating Sources | Number of States* | Number of Counties** |
|---|---|---|
| Hospitals | 16 | 2 |
| (Community) Health Care Facilities | 8 | 2 |
| Doctor's Clinics | 3 | 2 |
| Dental Surgeons | 0 | 2 |
| Clinical, Research & Teaching Laboratories | 10 | 2 |
| Veterinary & Other Animal Care Facilities | 5 | 1 |
| Mortuaries & Funeral Homes | 0 | 2 |
| Coroner Offices | 0 | 0 |
| Pharmaceutical Suppliers | 1 | 2 |
| Crematoria | 1 | 0 |
| Blood Banks | 1 | 1 |
| Others | | |
| Dialysis | 3 | 0 |
| Ambulatory Surgical Facilities | 2 | 1 |
| Any Generator | 5 | 0 |

* Out of 24 states
** Out of 2 counties

TABLE 7.4: SUMM[illegible]Y OF ACCEPTABLE TREATMENT PRACTICES FOR BIOMEDICAL WASTES PRIOR TO LANDFILL DISPOSAL AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Acceptable Treatment Practices | Number of States* | Number of Counties** |
|---|---|---|
| Incineration | 22 | 3 |
| Steam Sterilization (Autoclaving) | 16 | 3 |
| Thermal Inactivation | 3 | 2 |
| Chemical Disinfection | 3 | 1 |
| Others | 3 | 0 |

* Out of states

** Out of counties

## 7.4 DISCUSSION

In both Canada and the United States, no agency has taken the lead in establishing National regulations for the "cradle to grave" management of biomedical wastes.

In the United States, numerous states are attempting to standardize biomedical waste management within their jurisdictions by legislation. While many similarities exist between state regulations, numerous differences also exist. Furthermore, a state indicating that it regulates biomedical wastes does not necessarily have a separate biomedical waste management program. In many cases states have included the management of biomedical wastes under existing waste management or hospital licensure statutes.

In Canada, the most prominent method of including biomedical wastes under Provincial waste management regulations is through the adoption of the Federal Transportation of Dangerous Goods Act and Regulations.

In British Columbia, the B.C. Special Waste Regulation includes infectious waste by virtue of inclusion of those diseases listed in Schedule VII of the Federal Transportation of Dangerous Goods Regulations. The major deficiency of this system is that unless a biomedical waste is characterized as having one of the diseases listed in Schedule VII of the Transportation of Dangerous Goods Regulations, no Provincial controls exist for the management and disposal of such wastes.

The Task Force has identified the following needs concerning the legislation of biomedical wastes:

1. The current definition of infectious wastes as defined and categorized by the Federal Transportation of Dangerous Goods Regulations is inadequate. There is a need for the adoption of a definition of biomedical wastes that is more comprehensive and easier to implement.

2. To standardize Provincial management strategies for biomedical wastes there is a need for the development of Provincial regulations or guidelines. Such regulations or guidelines should include requirements for:

   - packaging
   - labelling
   - handling
   - in-house transport
   - in-house storage
   - pretreatment
   - off-site transport
   - off-site storage
   - on-site and off-site disposal
   - discharge of chemical sterilants such as ethylene oxide

   To ensure proper pretreatment and disposal of biomedical wastes, operating guidelines and criteria for applicable technologies are also needed.

3. Regulations or guidelines for biomedical wastes need to present options for biomedical waste management.

4. Regulatory controls for biomedical wastes need to be compatible at all levels of government: federal, provincial and municipal.

## 7.5 REFERENCES

De Castro, B.R., 1988. Technical Bulletin 88-2, Infectious Waste State Program Survey, National Solid Waste Management Association, Washington, D.C.

Thone-Kozimiensky, 1982. Recycling International: Recovery of Energy and Material from Residues and Waste, Berlin, Germany.

# 8.0 GENERAL BIOMEDICAL GUIDELINES

## 8.1 CANADIAN GUIDELINES

### 8.1.1 National

In Canada no Federal regulatory agency has developed comprehensive guidelines for the management of biomedical wastes.

Health and Welfare Canada

Health and Welfare Canada's "Infection Control Guidelines" (Health and Welfare Canada, 1985) provide health care facilities with a cursory approach to the inhouse management of biomedical wastes. Four waste streams: microbiology laboratory wastes; pathology wastes; blood and blood products; and certain sharps (eg. scalpel blades and needles) are identified as requiring special precautions. The Health and Welfare Canada guidelines make no reference to the segregation and labelling of wastes while packaging requirements are limited to recommendations for the use of puncture resistant containers for sharps and using impervious containers for infectious wastes. For inhouse transport of biomedical wastes the guidelines recommend that infectious waste should be transported in sealed impervious containers and that storage areas should be accessible only to disposal personnel. The guidelines state that infectious waste should either be incinerated or autoclaved prior to disposal in a sanitary landfill. Blood and blood products, suction fluids, excretions and secretions, as well as, infectious material capable of being ground and flushed may be disposed of via the sanitary sewer. No disposal method is specifically given for waste sharps (Health and Welfare Canada, 1985).

Canadian Standards Association

The Canadian Standards Association has recently published the second edition of its "Handling of Waste Materials Within Health Care Facilities" (CSA, 1988). Typically, CSA standards reflect a national consensus and are widely used by industry and are often adopted by Municipal, Provincial and Federal governments in their regulations or policies.

The CSA guide provides criteria for the segregation, collection, movement, storage and on-site disposal of waste materials within health care facilities. The standard, however, does not deal with the disposal of wastes once they have been removed from a generating facility, on the basis that such matters are the subject of Federal, Provincial and municipal regulations and legislation (CSA, 1988).

Canadian Red Cross Society

The Canadian Red Cross Society (CRCS) has recently published its own "Guidelines for Handling, Transporting and Disposal of Biomedical Materials" (CRCS, 1988). These guidelines apply to the segregation, collection, storage and transport of biomedical materials within the CRCS and its Blood Services Centres. Canadian Red Cross Society centres may adopt these guidelines directly or may develop other procedures which provide an equivalent level of protection to staff and the environment.

### 8.1.2 Provincial

British Columbia

The B.C. Ministry of Environment does not have specific guidelines pertaining to the management of biomedical wastes. Ministry policy has been to refer enquiries to the CSA Standards "Handling of Waste Materials Within Health Care Facilities"(CSA, 1988). The B.C. Ministry of Health handles requests in the same way (Environment Canada, 1988).

Ontario

The Ontario Ministry of Environment is currently the only Provincial government agency with both regulations and guidelines for the management of biomedical wastes.

In contrast to Ontario regulation 309 which provides a legislative requirement for the management of pathological waste, the Ontario Ministry of Environment's "Guidelines for the Handling and Disposal of Biomedical Wastes from Health Care Facilities and Laboratories" (Ontario Ministry of Environment, 1986) provides management strictly for pathological and infectious wastes.

The Ontario guidelines cover the precautions associated with the handling, collection, transportation, and disposal fo biomedical wastes and are recommended to be followed unless other measures taken are directly or expressly permitted by applicable Ontario or Federal legislation.

A summary of biomedical waste categories for the Canadian Standards Association, Canadian Red Cross Society and Ontario guidelines is given in Table 8.1. There is very little consistency between agencies.

Summary tables comparing recommended management strategies for biomedical waste streams identified by the Canadian Standards Association, Canadian Red Cross Society and Ontario guidelines are given in Appendix 8.1.

## 8.2 AMERICAN GUIDELINES

### 8.2.1 Federal

While no single Federal authority has written a baseline set of regulations for the management of biomedical wastes, several organizations including the Environmental Protection Agency (EPA) (United States Environmental Protection Agency, 1986), Centres for Disease Control (CDC) (Centers for Disease Control, 1980), and the Joint Commission on the Accreditation of Hospitals (JCAH) have issued guidelines recommending safe management practices.

Such guidelines present generators of biomedical wastes with a framework with which to manage biomedical wastes; however, these guidelines are not consistent. This disparity is largely due to fundamental disagreements as to what constitutes a biomedical waste, what management and disposal practices should apply and whether biomedical wastes present a real threat to public health. (DeCastro, 1988)

Table 8.2 provides a summary of biomedical waste categories recognized by the EPA and CDC guides. While the EPA recognizes seven types of institutions as potential generators of biomedical wastes, the CDC guidelines only apply to hospitals.

## TABLE 8.1
## CATEGORIES AND EXAMPLES OF BIOMEDICAL WASTES FROM CANADIAN BIOMEDICAL GUIDELINES

| CSA | | CRCS | | Ontario | |
|---|---|---|---|---|---|
| Category | Example | Category | Example | Category | Example |
| Human/Animal(1) Anatomical | - tissues<br>- organs<br>- body parts<br>- products of conception<br>- animal carcasses | Pathological Wastes | | Pathological Wastes | - human anatomical<br>- infectious animal anatomical |
| Infectious Nonanatomical | - microbiology labs wastes<br>- surgery/autopsy infectious diseases<br>- all waste from patients requiring communicable protocol | Hazardous Wastes | | Infectious Waste | - human anatomical<br>- animal anatomical<br>- nonanatomical<br>- microbial<br>- blood, blood product and body fluids<br>- isolation wastes |
| Sharps/Simular Wastes | - needles<br>- syringes<br>- blades<br>- glass, etc. | Infectious Wastes | - sharps<br>- plastics<br>- semi wets (gauze, swabs, etc.)<br>- reagents<br>- lab wastes<br>- liquid waste<br>- dry waste<br>- suspected HBs Ag or anit HIV positive | Special Handling Wastes | - sharps<br>- nonanatomical wastes which have been rendered non-infectious<br>- radioactive wastes |
| Chemical/ Pharmaceutical | - see Section 8.2 | Other Wastes | - outdated pharmaceuticals<br>- microbial contaminated | | |
| Radioactive Wastes | | | | | |
| Pressurized Container Wastes | | | | | |
| General Wastes | | | | | |

(1) Waste Category is subdivided into:
a) human anatomical b) infectious animal anatomical c) non-infectious animal anatomical

TABLE 8.2

CATEGORIES OF BIOMEDICAL WASTES RECOGNIZED BY THE
U.S. ENVIRONMENTAL PROTECTION AGENCY AND
CENTRES FOR DISEASE CONTROL GUIDES

| UNITED STATES CENTRES FOR DISEASE CONTROL | UNITED STATES ENVIRONMENTAL PROTECTION AGENCY |
|---|---|
| Pathological Wastes<br>Microbiological<br>Blood, Blood products, Exudents and Secretions<br>Sharps<br>Isolation Wastes | Isolation Wastes<br>Cultures, Stocks, Biologicals<br>Human Blood and Blood Products<br>Pathological Wastes<br>Sharps<br>Contaminated Animal Carcasses, Body Parts & Bedding<br>Surgery and Autopsy Wastes<br>Miscellaneous Laboratory Wastes<br>Dialysis Unit Wastes<br>Contaminated Equipment |

Fundamental differences between the EPA and CDC guidelines on the subjects of packaging, labelling, storage and transport of biomedical wastes are discussed in Appendix 8.2.

Treatment of Biomedical Wastes

A summary of recommended treatment options for biomedical wastes from the CDC and EPA guides is given in Table 8.3. A more detailed discussion of these is provided in Appendix 8.2.

Disposal of Biomedical Wastes

Both the CDC and EPA guides recommend incineration as the disposal option of choice for the majority of biomedical waste categories; however, landfill disposal and sewerage of some categories of biomedical wastes are permitted by both agencies following acceptable treatment.

Table 8.4 summarizes the recommended disposal options for biomedical wastes from both the CDC and EPA guides. A more comprehensive assessment of the disposal options recommended by the CDC and EPA is provided in Appendix 8.2.

### 8.2.2 States

In the absence of clear and consistent Federal guidelines or regulations, States and local Governments have been left to resolve the issues of biomedical waste management.

A number of States have developed regulations for the purpose of having enforceable controls, while other States have opted for guidelines for the management of biomedical wastes. California has developed both.

State guidelines for the management of biomedical wastes are discussed in Appendix 8.2.

## 8.3 EUROPEAN INITIATIVES

A review of European guidelines for biomedical waste management was limited to the United Kingdom's Health Services Advisory Committee's guidelines for clinical wastes (United Kingdom, 1982).

A summary of waste categories, recommended treatment and disposal practices for clinical wastes identified by the United Kingdom's Health Advisory Committee is discussed in Appendix 8.3

## 8.4 HOSPITAL ACCREDITATION REQUIREMENTS

### 8.4.1 Canada

In Canada, under hospital accreditation requirements (Canadian Council on Hospital Accreditation, 1986), the governing body and administration of a health care facility has the legal and moral responsibility for the operation of the facility. This includes health-care facility sanitation requirements, which include policies for the handling of biomedical wastes, addressing:

## TABLE 8.3

## RECOMMENDED TECHNIQUES FOR TREATMENT OF BIOMEDICAL WASTES FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY AND CENTRES FOR DISEASE CONTROL GUIDES

| Category of Biomedical Waste | Recommended Treatment Techniques | | | | | |
|---|---|---|---|---|---|---|
| | Treatment Sterilization | | Thermal Inactivation | | Chemical Disinfection | |
| | EPA[1] | CDC[2] | EPA | CDC | EPA | CDC |
| Isolation wastes | x | x | | | | |
| Cultures and stocks of infectious agents and associated biologicals | x | x | x | | x | |
| Human blood and blood products | x | | | | x | |
| Pathological Wastes | x | x | | | | |
| Contaminated Sharps | x | | | | | |
| Contaminated animal carcasses, body parts, bedding | | | | | | |
| - carcass & parts | x[3] | | | | | |
| - bedding | | | | | | |

[1] United States Environmental Protection Agency.

[2] United States Centres for Disease Control.

[3] For aesthetic reasons, steam sterilization should be followed by incineration of treated waste or by grinding with subsequent flushing to sewer in accordance with States and local regulations.

TABLE 8.4

## RECOMMENDED DISPOSAL OF BIOMEDICAL WASTES FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY AND CENTRES OR DISEASE CONTROL GUIDES

| Category of Biomedical Waste | Recommended Treatment Techniques | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Incineration | | Discharge to sewer | | Landfill | | Other | |
| | EPA[1] | CDC[2] | EPA | CDC | EPA | CDC | EPA | CDC |
| Isolation wastes | x | x | | | | | | |
| Cultures and stocks of infectious agents and associated biologicals | x | x | | | | | | |
| Human blood and blood products | x | x | x | x | | | | |
| Pathological wastes | x | x | | | | | x[3,4] | |
| Contaminated sharps | x | | | | | x | | |
| Contaminated animal carcasses, body parts, bedding | | | | | | | | |
| - carcasses | x | | | | | | | x[3] |
| - bedding | x | | | | | | | |

[1] United States Environmental Protection Agency.

[2] United States Centres for Disease Control.

[3] Following steam sterilization treated waste may be ground with subsequent flushing to the sewer in accordance with State and local regulations.

[4] Handling by a mortician (burial or cremation.

- packaging in red bags and puncture-proof containers (for sharps)
- storage: area, temperature, packaging integrity, and duration
- containment in sealed containers for liquid waste
- off-site transport to other facilities when sterilization or disposal cannot occur on-site
- assurance of safe transport practices
- sterilization procedures, where appropriate, particularly incineration and steam sterilization
- burial of decontaminated solid waste or disposal through the sewage system for decontaminated liquid waste.

For the purpose of accreditation the following terms are defined:

Biomedical Waste: waste which would pose a substantial present or potential hazard to health or the environment when improperly treated, stored, transported, disposed or otherwise managed. This includes anatomical human or animal waste, as well as, infectious waste.

Shall or must: terms used to indicate a mandatory statement, the only acceptable method under the present standards.

### 8.4.2 United States

According to the American hospital accreditation agency (Joint Commission on Accreditation of Hospital, 1982), sanitation requirements for health-care facilities in the United States shall include:

- Solid wastes should be segregated and packaged at the point of origin with a minimum of handling.
- Patient or animal care waste known to be potentially hazardous, such as isolation waste, secretions, excretions or blood, shall be sealed in impervious containers for handling within the hospital. Such containers shall be specifically identified and kept closed or sealed until final disposal.
- Syringes and sharps should not be placed in easily punctured containers.
- Laboratory wastes such as culture plates, tubes, sputum cups, swabs and the like shall be; sterilized by autoclaving prior to washing or discarding, or, sealed in impervious containers clearly marked for special handling and then incinerated.
- Animal carcasses and unpreservable tissue from surgical and necropsy specimens may be sealed in impervious containers clearly marked for special handling and should preferably be incinerated.
- When permitted by authority having jurisdiction, infectious waste may be ground up and disposed of via sewage channels or may be appropriately buried in an approved landfill.
- Incinerators used by hospitals shall produce complete combustion of all waste products and be in accordance with local, State and Federal regulations.
- Incinerators used for such purposes shall be located on-site or in close, off-site proximity.
- The hospital shall have a current environmental certificate for the incinerator if so required by the authority having jurisdiction.

## 8.5 GUIDELINES FOR CHEMICAL AND PHARMACEUTICAL WASTES

Many chemicals and pharmaceutical products used in health care facilities pose an occupational and environmental hazard due to the dangerous properties inherent in these products. Numerous associations from the health care industry, as well as agencies for health and environment, have developed guidelines for the safe management of chemical and pharmaceutical wastes.

### 8.5.1 Chemical Wastes

Chemical wastes come from diagnostic, experimental, housekeeping and disinfection procedures. The CSA defines hazardous chemicals as:

- toxic
- corrosive (acids pH <2.0 and bases pH >12.0)
- flammable
- reactive (explosive, water reactive, shock sensitive) or
- genotoxic

Health care facilities are recommended to comply with applicable Federal, Provincial and municipal regulations and legislation concerning disposal of chemical wastes (Canadian Standards Association, 1988)

### 8.5.2 Pharmaceutical Wastes

Pharmaceutical wastes include drugs and medicinal chemicals that are no longer usable, are outdated, are contaminated or are no longer required.

Canadian guidelines generally recommend the following practices for managing pharmaceutical wastes (Canadian Standards Association, 1988; Canadian Society of Hospital Pharmacists, 1981).

- development of policies and procedures for their management
- waste generation should be minimized through preplanning
- transportation of packages should be labelled to conform with Federal, Provincial, State or Municipal Regulations or Legislations
- pharmaceuticals should be packaged in sealable plastic bags before being placed in shipment containers, to contain possible spills
- biologicals and live attenuated vaccines should be placed in rigid, leak proof containers colour coded yellow and disposed of by:
    a) incineration
    b) autoclaving and deposing with normal refuse
    c) discharged to sanitary sewer
    d) other acceptable treatment or disposal techniques
- other pharmaceuticals should be placed in waste containers colour coded black or dark green
- pharmaceutical waste should be disposed of in a manner which prevents reuse, and the disposal options include:
    a) returning materials to the manufacturer
    b) incineration
    c) landfill

### 8.5.3 Antineoplastic/Cytotoxic Pharmaceutical Wastes

Antineoplastic (anti-new growth; anti-cancer) drugs, also called cytotoxic drugs, because they are toxic to cells, pose a particular occupational health risk to health care workers. In therapeutic doses, antineoplastics produce toxic side effects due to their poor selectivity between target cells (cancer cells) and normal cells. There is evidence that many of these drugs induce neoplasms and leukemias, cause testicular and ovarism dysfunction including permanent sterility, produce cumulative chromosomal damage and are associated with organ damage in cancer patients receiving long term therapy (Saskatchewan, 1985). There are conflicting reports in the literature concerning the possible effects on personnel of low-level exposure to antineoplastic drugs (Ontario Hospital Association, 1982). Concern for the safe handling, administration and disposal of antineoplastic drugs and their wastes have prompted numerous agencies to develop guidelines.

In Canada, guidelines for antineoplastics and cytotoxic pharmaceuticals have been developed by Ontario (Ontario Hospital Association, 1982), Manitoba (Manitoba Cance Treatment and Research Foundation, 1984), Saskatchewan (Saskatchewan, 1985), the Canadian Society of Hospital Pharmacists (Canadian Society of Hospital Pharmacists, 1981) and the Canadian Standards Association (Canadian Standards Association, 1988). The CSA's recommendations are based on guidelines recommended by the CSHP.

In the United States, guidelines for antineoplastics have been issued by the National Institute of Health (NIH) (Vaccari, et al, 1984), American Society of Hospital Pharmacists (ASHP, 1985), Michigan Department of Public Health (Michigan, 1985) and the Occupational Safety and Health Administration (OSHA, 1986).

In contrast to guidelines for other biomedical waste categories, guidelines for antineoplastic/cytotoxic drugs and wastes are generally more consistent between agencies. Management strategies shown in Appendix 8.4 represent an overview of recommendations from these guides.

Major points addressed are:

- personal protective equipment
- packaging, segregation and labelling
- storage - security and labelling
- on-site and off-site transport
- disposal

## 8.6 GUIDELINES FOR HUMAN IMMUNODEFICIENCY VIRUS (HIV)/AIDS

The Centres for Disease Control (CDC), Atlanta, Georgia, has developed and published in the Morbidity and Mortality Weekly Report "Recommendations for Prevention of HIV Transmission in Health Care Settings". The Canadian Centre for AIDS in collaboration with the Bureau of Communicable Disease Epidemiology, Laboratory Centre for Disease Control endorses these recommendations (Health and Welfare Canada, 1987).

Recommendations published by the CDC for the handling of HIV contaminated materials are modelled on precautions recommended for the Hepatitis B Virus (HBV), since the transmission pattern and epidemiology of HIV infection is similar to that of HBV infection (CDC, 1986a; Health and Welfare Canada, 1987). Accordingly, parenternal or percutaneous exposure to a needle or other sharp instrument contaminated with the blood of an infected person presents the greatest potential risk for the transmission of HIV to health care workers. However, the risk of acquiring HIV infection from needlestick exposure is considerably less than that of acquiring Hepatitis B viral infection (Health and Welfare Canada, 1987). Current evidence indicates that despite epidemiological similarities between HBV and HIV infection, the risk of acquiring HBV infection follow needlestick from an HBV carrier ranges from 6% to 30%, while infection following a needlestick from a patient with HIV is less than 1% (Steff, et al, 1987; Grady, et al, 1986)

The increasing prevalence of HIV increases the risk that health care workers will be exposed to blood from patients infected with HIV, especially when blood and body fluid precautions are not followed for all patients. The Centres for Disease Control and Health and Welfare Canada (Health and Welfare Canada, 1987) therefore recommend that health care workers consider all patients as potentially infected with HIV and/or other blood-borne pathogens and that rigorous infection control precaution for minimizing the risk of health care worker exposure to blood and body fluids for patients be followed.

Sterilization and disinfection procedures and currently recommended for use in health care and dental facilities are considered adequate to sterilize or disinfect instruments, devices or other items contaminated with blood or other body fluids from individuals infected with HIV (Favero, 1985; CDC, 1986b). Studies have shown that HIV is inactivated rapidly after being exposed to commonly used germicides at contaminations below those which are normally used (Health and Welfare Canada, 1987). In addition to chemical germicides, a solution of sodium hypochlorite (household bleach) prepared daily is an inexpensive and effective germicide. Concentrations ranging from 500 ppm to 5000 ppm are effective depending on the amount of organic material present on the surface to be cleaned and disinfected (Health and Welfare Canada, 1987)

Recommendations from Centres for Disease Control and Health and Welfare Canada for the disposal of contaminated materials include:

- syringes, needles, scalpel blades and other sharps should be discarded immediately after use in puncture-resistant containers. Containers should be clearly labelled to indicate potential infectiousness (ie., biohazard symbol, danger infection),
- non-liquid disposable items and materials from dissection, biopsy, etc. should be placed in tightly secured double plastic bags clearly labelled for potential infectiousness and autoclaved or incinerated,
- body fluids that are not saved and contaminated water should be treated with sodium hypochlorite solution before being discharged down the drain.

## 8.7 GUIDELINES FOR BIOMEDICAL WASTES FROM LABORATORIES

### 8.7.1 General Guidelines for Laboratory Safety

Laboratory personnel are subject to a wide range of hazards associated with the materials that are examined and processed through these facilities. However, many laboratories, whether hospital, university, school or private sector have until recently tended to downplay or ignore the hazards.

The Canadian Society of Laboratory Technologists has recently issued "CLST Guidelines for Laboratory Safety" (CLST, 1986). This guidance document provides the general precautions that should be followed by laboratory workers as well as provides guidelines aimed at safety in specific laboratory environments such as clinical chemistry, clinical microbiology and haematology.

General Provision for the Transport of Specimens

- Place samples in securely closed, sturdy water-tight container (vial, tube, bottle); where containers has screw top, the cap should be taped after closure.
- Primary containers should be enclosed in durable, water-tight container, strong plastic bags that can be sealed may be suitable.
- The secondary container should contain sufficient absorbent material to absorb the entire fluid content should leakage or breakage occur.
- Each set of primary and secondary containers should be placed in a rigid outer shipping container.
- Packages must be labelled with respect to contents before shipment.

General Provisions for Waste Disposal

- Many specimens may be discarded into the sewer system, however, Provincial legislation should be consulted prior to disposal.
- All material should be rendered microbiologically safe, preferably by autoclaving prior to leaving the laboratory, with the exception of materials being sent for incineration.
- Clots should be placed into leak proof plastic or waxed bags for autoclaving or incineration.
- Fluids and serum may be decanted into a beaker containing 1% hypochlorite and discharged down the drain.
- Urine may be discharged into the drain and the sink rinsed with 1% hypochlorite.
- Feces containers and tissues should be placed in plastic bags and incinerated.
- Sputum should be autoclaved or incinerated.
- Used needles must be placed in puncture proof containers and autoclaved before disposal.

### 8.7.2 Laboratory Guidelines for Biohazardous Materials

Guidance documents for biosafety are generally found to vary from one agency to another and from on country to another.

The World Health Organization (WHO, 1983) in reviewing such publications found that these guidance documents reflected particular features of the organization and administration of laboratories, the health and safety legislation and categorization of pathogenic microorganisms obtained from their country of document origin. Further, manuals dealt with defined aspects of the subject, such as handling of dangerous pathogens, or the putative hazards of genetic manipulation, while others are written solely for use in a particular institution or type of laboratory (WHO, 1983).

For the purpose of this assessment, documents from the World Health Organization (WHO, 1983), the National Institute for Occupational Safety and Health (NIOSH) (Flury, 1978) and the Medical Research Council of Canada (MRC, 1980) were reviewed. All three documents focus on the development of safe laboratory practices, safety procedures and containment levels for microbiology laboratories or research laboratories using biohazardous organisms such as recombinant DNA molecules, and animal viruses and cells. Appendix 8.5 summarizes the basic features of these documents.

The general issues addressed include:

- containment levels, risk group levels, and biohazard classes
- laboratory access
- packaging requirements
- decontamination and disinfection
- disposal

## 8.8 DISCUSSION

Numerous guidelines have been published for the management of biomedical wastes or specific categories of the biomedical waste stream such as antineoplastic drugs, AIDs wastes and recombinant DNA.

While guides for antineoplastics, AIDs and laboratory biohazards such as recombinant DNA or animal viruses and cells are for the most part consistent between agencies and jurisdictions, other guides most typically those dealing with the general biomedical waste stream are found to vary. Such variation in the latter type of guidance documents is often attributed to the fundamental disagreement between agencies as to what constitutes a biomedical waste and what waste management practices should apply.

In the United States, the existence of several different guides has resulted in various institutions from within the same state and even the same city following different management practices for biomedical wastes. With no Federal statutes, regulations or guidelines to follow, state and local agencies have been left to resolve their biomedical waste problems and to develop their own biomedical waste management programs.

In Canada, the situation is similar. There exist no Federal statutes or guidelines for the comprehensive "cradle to grave" management of biomedical wastes. The current CSA standards closely resemble the guidelines published by the US EPA and provide criteria for the simplification of segregation, packaging, handling, storage, treatment and on-site disposal of biomedical wastes. However, CSA standards do not address the disposal requirements for wastes transported off-site. Waste categories included in the current CSA standard include:

1. Human/animal anatomical waste:
   Human anatomical, infectious animal anatomical, noninfectious animal anatomical
2. Infectious nonanatomical waste:
3. Sharps and similar waste:
4. Chemical/pharmaceutical waste:
   Chemical, pharmaceutical, cytotoxic pharmaceutical
5. Radioactive waste:
6. Pressurized container waste:
7. General waste:
   office, kitchen, nonclinical glass, noninfectious nonanatomical

Guidelines for the in-house handling of biomedical wastes generated from patients with HIV are considered by health care professionals to be more than adequate for the protection of health care workers.

Guidance documents for laboratories engaged in biohazards research or analysis including recombinant DNA and animal viruses and cells, while fairly consistent between agencies such as the MRC and the WHO, do not guarantee the proper treatment or disposal of biomedical wastes. Such documents "recommended" treatment and disposal practices or state what practices "should" be followed, rather than state what management practices are required for the safe disposal of biomedical wastes. Further, these guidance documents leave suitable disposal practices in part to the discretion of local regulatory authorities and an institute's biohazards committee.

The Canadian Council of Resource and Environment Ministers (CCREM) is currently studying the biomedical waste issue with the view of establishing a National code of good practice.

### Needs and Gaps

1. Deficiencies observed for the current CSA guidelines include:
   - Failure to address off-site biomedical waste management practices at all, and on-site disposal and treatment is not addressed thoroughly. The guidelines appear designed more for the protection of workers in health care facilities, than the public, the environment, or disposal workers.
   - Blood, blood products, and body fluid wastes are not well classified and managed.
   - A method to identify the status of biomedical wastes that have been rendered non-infectious by pretreatment is not provided.
   - They do not include comprehensive guidelines for biomedical wastes of animal origin.
   - They recommend that filled sharps containers and pharmaceutical wastes (excluding cytotoxics) slated for disposal be enclosed in dark green or black plastic bags, which can be indistinguishable from typical refuse bags.
   - Absence of recommendations for recombinant DNA and biotechnology wastes.
2. Current MRC and WHO guidelines for laboratories handling biomedical agents are inadequate in addressing the safe treatment and disposal of biomedical wastes.
3. Experience from the United States and British Columbia suggests the need for enforcement methods for biomedical waste guidelines.

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# 9.0 REGULATORY AGENCY ADMINISTRATIVE ACTIVITIES

## 9.1 B.C. MINISTRY OF HEALTH

The Ministry of Health, British Columbia, has an interest in the subject of biomedical wastes from two perspectives:

### 9.1.1 Division of Hospital Programs and Institutional Services

The hospitals of the Province are under the control of the respective Hospital Societies and, as such, are separate legal entities in themselves. The administrative responsibility and control of the hospitals rests with the respective Boards of Trustees, under the provisions contained in the Hospital Act and the Hospital Act Regulations.

Hospitals are funded by the Ministry of Health on a global basis and the range and priority of services provided by the hospital is the responsibility of the Board of Trustees. At times, the Ministry of Health comes to some special funding arrangements for certain tertiary and Provincial referral services, where accountability is more closely tied to specific funding.

The Division of Hospital Programs and Institutional Services has no direct influence or concern with the management of biomedical wastes, but has indirect concern mediated through the accreditation process of hospitals by the Canadian Council of Hospital Accreditation, and the separate accreditation process specifically oriented towards laboratories. The standards that are endorsed by these accreditation bodies are recognized and supported by the Ministry of Health. Also, the Ministry supports and encourages hospitals to act in cooperation with one another and the Regional Districts to effect appropriate biomedical waste practices.

Insofar as the disposal of biomedical wastes is funded as part of overall hospital activities, the Division of Hospital Programs and Institutional Services is very concerned that the waste stream management system involving hospitals is both realistic and cost effective. The Ministry of Health is concerned that problems being experienced in the waste stream management system are properly identified and that those problems which belong to the management stream outside of hospitals are not transferred to the hospitals unnecessarily, or without proper justification.

The Ministry of Health joins the Regional Districts in the capital funding of hospitals which includes equipment or facilities designated for the treatment of biomedical wastes.

### 9.1.2 Division of Preventive Health Services

The general activity of this Division addresses issues of Public Health within the provisions of the Health Act. The staff of the Division enter into institutional inspection of matters relating to catering services but not routinely relating to matters of biomedical waste handling or disposal. The hospitals have infection control committees, nursing, and housekeeping practices to provide for internal observation of appropriate handling of infectious materials. The Health Officers only become involved when problems arise which threaten public health and safety.

## 9.2 B.C. MINISTRY OF ENVIRONMENT

The Waste Management Branch of the Ministry of Environment is charged with the responsibility of administering programs related to the management of biomedical wastes. In part, this activity involves the administration of the Waste Management Act and Special Waste Regulation, which specifically address biomedical wastes, as described in Chapter 7. A manifest system to track shipments of those biomedical wastes that qualify as special wastes has been legally in operation since April 1, 1988.

Since the early 1980's it has been the practice of the Waste Management Branch to advise biomedical waste generators that the Canadian Standards Association Standard for waste materials in health care facilities should be used for guidance.

Regarding biomedical waste disposal, only one of the Ministry's regional waste management offices has issued permits for biomedical waste incinerators, because of the absence of provincial guidelines or criteria. This office has developed an inventory of biomedical waste incinerators and a plan to ensure they are permitted under the Waste Management Act.

## 9.3 OTHER PROVINCIAL GOVERNMENT AGENCIES

The Ministry of Labour and Consumer Services administers the Cremation Act. The responsibility of certifying crematoria lies with the chief engineer of the Ministry of Transportation and Highways, and this is currently carried out by an engineer recently retired from that Ministry.

## 9.4 GREATER VANCOUVER REGIONAL DISTRICT (GVRD)

In response to continuing problems with biomedical waste management, and to coordinate representation and input into this Task Force's activity, the Greater Vancouver Regional District formed the "GVRD Biomedical Waste Coordination Committee" in January 1988. To deal with immediate biomedical waste problems in the area, this committee proposed a five part policy which was communicated to Lower Mainland hospitals. The policy contains the following main features:

1 ) Biomedical waste found in the municipal waste system will be removed and disposed of by a biomedical waste management company. The costs will be charged to the generator.

2 ) Offending generators will be notified of each offense and given the opportunity to view the offending material. Meetings will be held to discuss measures to prevent recurrences.

3 ) Failure to comply may result in the loss of general waste disposal services offered by the GVRD.

4 ) Meetings will be held with representatives of all Lower Mainland hospitals and medical laboratories to discuss biomedical waste disposal problems and to develop acceptable solutions.

5 ) The GVRD will develop guidelines to deal with immediate biomedical waste problems in the Lower Mainland until long-term solutions become available.

Existing hospital incinerators within the Greater Vancouver Regional District are currently regulated under the Air Pollution Control Bylaw No. 92. Main requirements under this bylaw are:

- valid operating permit, issued by the District Director,
- 40 percent opacity,
- 150 grains of particulate matter per 1000 $ft^3$ of flue gas at 68°F and 12 percent $CO^2$ (343 $mg/m^3$).

Hospital incinerators in operation before 1973 are allowed to operate without an operation permit but they must meet the above emission requirements.

The GVRD Air Pollution staff is preparing a new bylaw to be known as the "Air Pollution Control Bylaw No. 603." This bylaw will replace the Air Pollution Control Bylaw No. 92. The hospital incinerators will not be regulated under the new bylaw which will apply only to incinerators burning domestic and commercial waste within Types A, B, and C of Schedule A of the draft bylaw (Appendix 9.1).

The hospital incinerators will be regulated under the Waste Management Act. The main requirements of the Act are:

- a valid permit of operation which, within the GVRD, will be issued by the GVRD Pollution Control Department and, within the remainder of the Province, by the Waste Management Branch;
- meeting the emission requirements which will be set according to the best available technology and emission standards. Emission requirements similar to the emission criteria proposed in the new Bylaw No. 603 are to be expected.

The new municipal solid waste incinerator in Burnaby is owned by the GVRD This facility has the inherent capability to properly dispose of biomedical wastes by incineration; however, a policy on using the facility for this purpose would have to be established by the GVRD Administration Board.

## 9.5 FEDERAL GOVERNMENT AGENCIES

Several Canadian federal government agencies are involved with biomedical wastes. Transport Canada, as administrator of the Transportation of Dangerous Goods Act, has played a major role in defining what wastes qualify as infectious wastes across Canada. Many jurisdictions, including British Columbia, have adopted the definition embodied in this legislation.

Environment Canada has published a report summarizing the state-of-the-art for biomedical wastes, and is taking the lead in establishing national guidelines for biomedical waste management, as described below.

In British Columbia, Health and Welfare Canada has sometimes assisted with the incineration of pharmaceutical, infectious or anatomical wastes, by making special arrangements with incinerator operators.

## 9.6 CANADIAN COUNCIL OF RESOURCE AND ENVIRONMENT MINISTERS (CCREM)

The Canadian Council of Resource and Environment Ministers currently has several initiatives to develop guidelines and controls for biomedical wastes. Under the CCREM Waste Management Committee, a Biomedical Waste Steering Committee has been struck to develop a complete code of practice for the management of biomedical wastes for the use by regulatory agencies, institutions, industry and the public. This Committee has members from several provinces, including British Columbia, and is chaired by Environment Canada. The CCREM Research Committee has considered supporting research into biomedical waste incineration.

## 9.7 DISCUSSION

It is evident that regulatory agencies at all levels of government in British Columbia are concerned about the management of biomedical wastes and intend to do something about the situation. Where there have been acute problems, short-term solutions have been developed and implemented, as in the example of the Greater Vancouver Regional District's ad hoc biomedical waste committees and policies.

On the other hand, where the goal is to develop long-term solutions, regulatory authorities have chosen to participate in biomedical waste initiatives at the provincial and national level.

One anomaly in the provincial administration of biomedical wastes is evident with the Cremation Act. It seems most unusual that this Act requires certification of a crematorium by the chief engineer from the Ministry of Transportation and Highways, whose broad mandate does not focus on waste management or criteria for incineration design, operation and emissions. On the other hand, considerable incinerator engineering expertise lies within the Ministry of Environment, and it may make sense for this function to be transferred to this Ministry.

# 10.0 SUMMARY OF REPORTS ON BIOMEDICAL WASTES

## 10.1 RATIONALE

The complexity and magnitude of the real or perceived problems associated with the disposal of biomedical wastes, requires an appropriate attempt to bring the various aspects of this issue into focus in order for the Task Force to develop recommendations for British Columbia.

One approach is to review selected reports prepared on the subject from the United States and Canada. Nine recent and comprehensive reports were obtained so that the various issues could be placed into perspective without having to undergo extensive local surveys and literature searches. The local surveys could then be used to provide clarification of issues and to verify the existence of local problems similar to those being experienced in other jurisdictions. A summary of the major features of nine different reports on biomedical wastes is provided in Appendix 10.0

## 10.2 DISCUSSION

Nine different reports on the subject of biomedical waste management were reviewed in detail, with a focus on the conclusions and recommendations from each. The mandates of the authors of these reports sometimes differed and their conclusions and recommendations sometimes were divergent. For example, on one hand, the New Jersey State Grand Jury (New Jersey, 1987) and the Seattle-King County Department of Public Health (Seattle-King County Department of Public Health, 1988) made strong and/or detailed recommendations for regulatory controls for biomedical wastes. In contrast, the Ohio Infectious Waste Ad Hoc Advisory Committee (Ohio, 1987) felt there was no need for further legislative action, and that the Centres for Disease Control guidelines were adequate.

Two reports from Ontario have a different focus (Ontario Interministry Task Force, 1988; Hospital Council of Metropolitan Toronto, 1986). In this jurisdiction, which already has biomedical waste legislation, the major problems to be faced were to develop facilities to manage biomedical wastes. Options for centralized facilities in Toronto were reviewed (Hospital Council of Metropolitan Toronto, 1986), with the conclusion that a central biomedical waste incinerator was not cost effective, but that central shredding/disinfection and/or autoclaving be pursued. Further details on all the reports are provided in the Appendix to this chapter.

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# 11.0 GENERAL DISCUSSION

## 11.1 INTRODUCTION

This chapter summarizes the major observations and needs identified in previous chapters in this report, and is organized following the subject order used in the preceding chapters.

In reviewing observations and identifying needs for the management of biomedical wastes, the Task Force narrowed its scope by eliminating several sources of wastes from in-depth consideration. The evidence received suggests that dentists, orthodontists, periodontists, oral surgeons, mortuaries, funeral homes, crematoria, medical offices, and pharmaceutical suppliers are now not causing or encountering significant biomedical waste problems in B.C. Coroner's facilities were always found to be associated with a hospital and their waste can be considered as part of the hospital waste stream. However, there may be a few specific problems, such as the management of sharps, from sources such as Public Health Units and these will be considered specifically below.

## 11.2 DEFINITION AND CLASSIFICATION OF BIOMEDICAL WASTE

### 11.2.1 Summary of Observations

During the course of its deliberations, the Task Force realized that the working definitions it had developed at the outset required some fine tuning. The definition for biomedical waste does not include reference to humans or animals. In addition, the Task Force observed that while the waste categories it used were good for developing and describing a wide range of controls for biomedical wastes, it was also important for generators to have available simple and easily identified classes of biomedical wastes that require special treatment and disposal. The classes in the "EPA Guide for Infectious Waste Management," slightly modified as shown in Appendix 11.1 appear to fulfill this need, and have been termed "special biomedical wastes."

In reviewing its working categories for biomedical wastes, the Task Force observed that the general distinction between solid and liquid wastes made for human anatomical wastes also could have been made for infectious animal wastes, infectious microbiological wastes and chemical and pharmaceutical wastes. As well, a number of other categories of biomedical waste were discussed, including:

- noninfectious animal anatomical waste
- pharmaceutical contaminated animal anatomical waste
- equipment and materials contaminated with chemical and pharmaceutical waste

The Task Force did not pursue management strategies for these additional categories.

The Task Force's review of various definitions and classification schemes for biomedical wastes in Chapter 2.0 indicates a lack of uniformity among jurisdictions and standard setting agencies in North America. For example, the existing terminology used in some municipal bylaws to address biomedical wastes can be rather vague. This creates various problems for biomedical waste generators, carriers, and managers, particularly when individuals are required to handle biomedical wastes in different jurisdictions, or waste transfers from one jurisdiction to another.

Under the Transportation of Dangerous Goods Act a uniform definition for infectious waste is in place across Canada, but it does not include all the biomedical waste streams identified in this report. A broader definition is currently being developed. As well, the Task Force did not address in depth wastes contaminated with products of recombinant DNA research; however, this waste stream is slated for inclusion in the Federal definition under the Transportation of Dangerous Goods Act.

Part of the Task Force's time was devoted to discussion of the small quantity sources of biomedical wastes such as households. It was observed that these sources could be important but that it would be difficult for them to be regulated in the same way as large quantity generators.

### 11.2.2 Needs

The Task Force has observed that there is an immediate need for a uniform definition for biomedical waste in British Columbia, and that such a definition is also needed for all of Canada. Municipal definitions covering biomedical wastes need to be reviewed to check for correspondence with any Provincial definitions adopted or developed, to reduce conflicts in terminology, and to avoid defining wastes that are not needed to be regulated. Uniform methods for exempting certain biomedical waste sources, types, quantities or disposal options also need to be considered. The Task Force also found that its working definitions need to be expanded, and that it would be useful to provide a list of biomedical waste sources and types that require special management techniques, such as that shown in Appendix 11.1.

## 11.3 HAZARDS AND IMPACTS OF BIOMEDICAL WASTE

### 11.3.1 Summary of Observations

The Task Force has concluded that there are three major classes of potential physical hazards associated with biomedical wastes: infection; which includes communicable diseases such as AIDS and Hepatitis B; chemical hazards, which include acute toxicity, cancer, bioaccumulation of chemicals, and corrosion; and physical injury, particularly from sharps such as hypodermic syringe needles. Also, various reactions to biomedical wastes depend to a large extent on the extent of the risk perceived.

A variety of media can be contaminated by biomedical wastes, and the receptors include patients, institutional workers, waste management workers, and the public and wildlife adjacent to biomedical waste handling areas. For infectious disease to occur, a source of the infecting agent must exist, a mode of transmission must be available, and a susceptible host must be present.

In British Columbia, human disease is not known to have occurred from handling these wastes, perhaps because the data suggest they are normally pretreated before disposal to sanitary sewer or landfill.

As well as physical impacts, the psychological aspects of biomedical waste management are extremely important. The perception of risks posed by biomedical wastes varies remarkably from, for example, waste management worker, to health care professional. In many cases, perceptions and attitudes have largely dictated the management strategies chosen.

The Task Force found little evidence on the hazards, fate, and impacts of biomedical wastes when disposed of in sewer systems or sanitary landfills, or of small quantity biomedical wastes on human health and the environment.

### 11.3.2 Needs

The Task Force has identified the need for understanding of the facts of the issue by all biomedical waste stakeholders. Clear, factual information on the hazards, receptors, exposures, and impacts of biomedical wastes and their by-products, such as incinerator emissions are required. This need is particularly great for special biomedical wastes. In addition, continued monitoring of research into the hazards and impacts of biomedical wastes is required.

## 11.4 NON-GOVERNMENTAL STAKEHOLDER ACTIVITIES

### 11.4.1 Summary of Observations

The Task Force met and/or otherwise communicated with a host of biomedical waste stakeholders. Since the Task Force is composed of representatives from government agencies, its members represented the needs and concerns of provincial and municipal government agencies in B.C. The needs of non-governmental biomedical waste stakeholders were directly solicited, and the following broad conclusions can be made from this input:

- Non-governmental biomedical waste stakeholders desire guidelines for a wide range of biomedical waste management issues. Guidelines for biomedical waste segregation, handling, packaging, on-site transport and storage, pretreatment, disposal, off-site storage and transport, spill response, and contingency planning, plus a uniform definition for biomedical wastes and guidelines for handling sharps are desired.

- Numerous private sector interests indicated that they are willing to manage biomedical wastes in B.C., and one company is currently very active in the Lower Mainland. Some private sector interests who offer disposal facilities have complained about potential competition from the public sector, through publicly funded disposal options.

- Biomedical waste generators indicated they wanted cost effective systems to manage their wastes.

- While some biomedical waste generators suggested that central biomedical waste management facilities are needed for the use of many generators, others said they wished to be self-sufficient.

- Several biomedical waste generators expressed the fear that the United States border could be closed to the export of biomedical wastes, thus cutting off a major disposal option currently used in the Lower Mainland.

### 11.4.2 Needs

Five main needs were identified by the non-governmental biomedical waste stakeholders:

1 ) A uniform system of administering, managing, and communicating about biomedical waste is required.

2 ) The roles of the private and public sectors in biomedical waste management, particularly in the area of disposal facility ownership, need to be clarified, and a method for obtaining this clarification needs to be established.

3 ) Various technological options for managing biomedical wastes are required, including facilities for use by multiple, as well as individual waste generators.

4 ) Contingency plans are needed to prepare for the possibility that borders close to exports of biomedical waste, and for the possible loss of other biomedical waste options currently used in British Columbia.

5 ) Education programs on biomedical wastes for the public, waste generators, and waste handlers are required.

## 11.5 BIOMEDICAL WASTE INVENTORY ISSUES

### 11.5.1 Summary of Observations

Numerous sources of biomedical wastes were identified by the Task Force, and hospitals, dentists, veterinarians, and research laboratories were directly surveyed. The types of biomedical wastes generated from various B.C. sources considered by the Task Force are summarized in Table 11.1. These sources were either found to generate the types of waste indicated, or in the absence of direct information, inferred to generate those wastes based on the nature of the activity carried out.

The types and quantities of biomedical wastes revealed by these surveys are similar to those elsewhere in North America, as shown in Tables 11.2 and 11.3, bearing in mind that these estimates are hindered by a lack of uniformity of definitions for biomedical wastes between jurisdictions. Very poor response to questionnaires sent to individual doctor's was received, so the Task Force has little information on the inventory from that source.

While these estimates reflect the data obtained by the Task Force in 1988, the widespread adoption of "universal precautions" provisions by health care facilities for wastes would have a major impact on the volumes of biomedical waste requiring management separate from the normal municipal solid waste stream. This could have a major impact on the sizing, and thus cost of biomedical waste facilities that may be developed in the future in the province. The Task Force has estimated a three to five fold increase in biomedical waste volumes upon adoption of "universal precautions". For biomedical waste generators, adoption of "universal precautions" would increase disposal costs but would be partially offset by a decrease in segregation, packaging, and handling costs.

## TABLE 11.1

## SOURCES AND CATEGORIES OF BIOMEDICAL WASTES IN B.C.

| | BIOMEDICAL WASTE CATEGORIES OBSERVED OR INFERRED | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| GENERATOR SOURCES | Solid Human Anatomical | Liquid Human Anatomical | Infectious Animal Solid and Liquid | Infectious Non-anatomical | Infectious Biological | Waste Sharps | Infectious Microbiological | Chemical/ Pharmaceutical Waste |
| Hospitals | √ | √ | √ | √ | √ | √ | √ | √ |
| Public Health Units | | | ? | | | √ | √ | |
| Doctors' Clinics | ? | ? | | ? | ? | √ | ? | √ |
| Dentists, Orthodontists, Periodontists, Oral Surgeons | √ | √ | | ? | | √ | ? | √ |
| Clinical, Research, and Teaching Laboratories | √ | √ | √ | √ | ? | √ | √ | √ |
| Veterinary and Other Animal Care Facilities | | | √ | √ | √ | √ | √ | √ |
| Mortuaries and Funeral Homes[1] | √ | √ | | √ | √ | √ | | ? |
| Coroners' Offices | √ | √ | | √ | ? | √ | | ? |
| Pharmaceutical Suppliers[1] | | | | | | | | √ |
| Crematoria[1] | √ | √ | | √ | | | | ? |
| Blood Banks | | √ | | √ | | √ | | ? |

[1] Categories inferred.

## TABLE 11.2

## COMPARISON OF LITERATURE BASED AND TASK FORCE SURVEY BASED ESTIMATES OF BIOMEDICAL WASTE GENERATION RATES AND WASTE VOLUMES

| | Biomedical Waste Generation Rate | |
|---|---|---|
| Information Source | Range of Generation Rates (kg/bed/day) | Average Generation Rate (kg/bed/day) |
| Canadian and U.S. literature | 0.03 - 1.87 | 0.5 |
| Task Force Survey Results | 0.02 - 4.45 | 0.78 |

## TABLE 11.3

## TOTAL ESTIMATED RATE OF BIOMEDICAL WASTE GENERATED IN B.C. IN 1987

| Estimate Source | Waste Volume (tonnes/day) |
|---|---|
| From Literature Based Average[1] Generation Rate | 10 |
| From Task Force Survey Average[1] | 16 |

[1] Based on 20,296 hospital beds. Hospital bed statistics for 1987 supplied by the Ministry of Health, Province of British Columbia.

### 11.5.2 Needs

Three needs the Task Force has noted concerning biomedical waste inventories are to:

- obtain a better idea of the volumes and types of biomedical wastes coming from small quantity waste generators such as doctor's offices and clinics,
- to estimate the range of biomedical waste volumes requiring treatment should "universal precautions" be widely adopted, and
- to adopt a consistent definition for biomedical waste to assist in making inventories from different studies comparable.

## 11.6 BIOMEDICAL WASTE MANAGEMENT TECHNOLOGIES AND PRACTICES

### 11.6.1 Summary of Observations

#### 11.6.1.1 Introduction

A variety of biomedical waste management practices are used in British Columbia. Major disposal methods include incineration, landfilling, and sewer system disposal. Several practices that have drawn numerous complaints including the compaction of biomedical wastes at transfer stations, the inclusion of human organs and contaminated equipment in typical municipal solid waste streams, injuries caused by contact with sharps, and unacceptable emissions from incinerators burning biomedical wastes.

The transport of biomedical wastes to the United States for disposal is causing some concern about the substantial increases in biomedical waste disposal costs since using this option. Facilities currently using this service are worried about the potential for the International border to close to such shipments.

Observations for specific biomedical waste management practices addressed by the Task Force are listed below:

#### 11.6.1.2 Segregation

While a number of generators segregate biomedical wastes from the general waste stream, many others do not. Such disparity has caused concern by waste handlers at facilities such as transfer stations and has resulted in work stoppages at these facilities because of this practice. While the lack of segregation may often be traced back to the generating facility, sometimes, despite the efforts of generators to segregate their biomedical wastes at the source, these wastes become mixed in with the normal solid waste stream, after the wastes have left the facility where they were generated.

#### 11.6.1.3 Packaging

Biomedical wastes are packaged in different containers such as plastic bags, rigid plastic containers, cardboard boxes, metal storage bins, etc. The compaction of biomedical wastes before disposal was not assessed by the Task Force, but would obviously lead to loss of integrity of packaging.

#### 11.6.1.4 Labelling

The Task Force observed nonuniform labelling practices. For example, different colour coding schemes are used for the same waste category at different hospitals, labels indicating a waste's pretreatment status are not used, and often labels were not used at all.

#### 11.6.1.5 On-site Storage and Transportation

While the Task Force did not thoroughly investigate the on-site storage and transportation of biomedical waste directly, there was little evidence received that there were major problems with the methods used or significant impacts produced. At one facility, potentially infectious non-anatomical wastes were stored unmarked and unlocked in an area outside the main building, easily accessible to the public. Such non-secure storage could be common practice.

#### 11.6.1.6 Pretreatment

The Task Force reviewed a wide range of treatment options for biomedical wastes, including steam, dry heat, gas and vapour sterilization, as well as irradiation and physical/chemical treatment. Where used, hospitals usually either pretreat by steam sterilizing with autoclaves or with bleach. About half of the hospitals surveyed do not pretreat any biomedical wastes before off-site disposal. The circumstances where sterilization would be preferred over disinfection were often not clear to the Task Force, in view of the lack of data on the impacts of biomedical waste disposal.

#### 11.6.1.7 Off-site Transportation and Handling

A large volume of biomedical waste is transported off-site in B.C. The destination is often a transfer station or a disposal site. These shipments are now being tracked by the special waste manifest system under the Provincial Waste Management Act.

#### 11.6.1.8 Central Disposal Facilities

The Task Force has noted that several jurisdictions are considering large scale facilities to manage biomedical wastes from large population areas. Some of the potential technologies include large incinerators, autoclaves, and waste grinding/treatment operations. A number of stakeholders have noted the potential for such facilities to be established in British Columbia, particularly in the Lower Mainland. The B.C. Ministry of Regional Development may have an interest in pursuing this issue.

#### 11.6.1.9 Incineration

History and Common Practice

Many biomedical waste generators use on- or off-site incinerators to dispose of their wastes. Only five pathological incinerators and one hospital incinerator are operating with a Waste Management Branch permit. None of the incinerators are equipped with pollution control equipment such as cyclones, scrubbers, or fabric filters. Currently many Lower Mainland hospitals are sending their biomedical wastes to an incinerator in Bellingham for disposal. The ash from incineration is landfilled.

Impacts

Although there has been little monitoring of biomedical waste incinerators in B.C., the Task Force expects that typical emissions from these incinerators would exceed the proposed guidelines of various jurisdictions, especially for particulates and hydrogen chloride. It has also been shown that biomedical waste incinerators produce toxic organic compounds which could also have some impact, depending on the receptors nearby and the quantities of contaminants discharged. The disposal of incinerator ash by improper landfilling also has the potential for creating adverse impacts, mainly from leaching of substances into surface and groundwater. The use of a wet scrubber to treat the incinerator flue gas is most likely to produce wastewater at the site, which may also produce unacceptable environmental impacts unless treated before discharge.

Technical Feasibility

State-of-the-art incinerators equipped with suitable pollution control equipment are capable of efficiently burning biomedical wastes. Their emissions and residues are similar to those from the incineration of municipal solid waste. The rotary kiln incinerator to be built by B.C. Special Waste Services in the Interior of the Province is technically capable of incinerating biomedical wastes properly, as is the new municipal solid waste incinerator in Burnaby.

### 11.6.1.10 Sanitary Landfill Disposal

History and Common Practice

Disposal of special biomedical wastes into sanitary landfills is usually not practiced routinely in B.C. if there is a biomedical waste incinerator available. Often infectious nonanatomical waste is sterilized before landfilling. Nevertheless, several waste streams such as infectious nonanatomical wastes and sharps such as needles, tubing, blood bags, etc. are frequently landfilled untreated outside of the Lower Mainland. The response from transfer station workers and landfill operators has been negative because of 1) failure to remove untreated biomedical waste from the normal refuse stream and 2) failure to properly identify pretreated biomedical waste. Chemicals and pharmaceuticals sometimes are disposed of in sanitary landfills with the normal refuse stream. The legal status of landfill disposal of biomedical wastes is generally not clear, although the Special Waste Regulation and some municipal bylaws forbid the disposal of some types of biomedical wastes. Some concerns were expressed about the use of solid animal anatomical waste that had been contaminated by pharmaceuticals and/or infectious organisms in fertilizer, pet food, and in other products from rendering plants.

Impacts

There are a number of potential impacts of landfilling untreated biomedical waste:

1 ) injury of workers from contact with sharps;
2 ) infection in workers following injury with contaminated equipment;
3 ) infection in scavengers and vectors contacting wastes;
4 ) contaminated leachate;
5 ) contaminated air emissions; and
6 ) psychological impacts on landfill workers.

Technical Feasibility

The sterilization of infectious waste before landfill disposal is routinely accomplished for small quantities of biomedical waste and the apparatus is readily available. However, despite their widespread use, there remains some controversy over the effectiveness of autoclaves to completely sterilize all types and sizes of biomedical waste loads, such as containerized sharps.

### 11.6.1.11 Sanitary Sewer Disposal

History and Current Practice

Untreated infectious liquids, including human, animal, and biological wastes have, and continue to be disposed of into sanitary sewer systems from a wide range of sources such as hospitals and households. This is standard practice for hospitals and includes blood, blood products and other fluids, but may not always be legal under provincial regulations or municipal bylaws. Chemicals and pharmaceuticals are sometimes disposed of by this method as well. Exceptions are solid microbiologicals and pathological waste, which are normally autoclaved or disinfected before disposal to sewer.

Impacts

Little, if any, evidence exists to indicate whether or not the disposal of health care facility liquid biomedical waste into sanitary sewer systems causes any greater impact than liquid biomedical wastes coming from households. The use of combined storm and sanitary sewer systems for the disposal of liquid biomedical wastes raises the same public health concern as the use of combined sewer systems for the disposal of raw sewage. There may be differences in perception, however, concerning the environmental impacts of these two waste streams. This concern stems from the fact that during periods of excess volume, wastes in these systems bypass treatment plants and are discharged untreated into the environment.

Technical Feasibility

The current situation of direct sewage disposal of infectious liquids is convenient and practical. The facility alteration requirements for the pretreatment of liquid wastes would need to be examined should the Task Force recommend that infectious wastes need to be pretreated before sanitary sewer disposal.

### 11.6.1.12 Disposal of Specific Hospital Waste Streams in B.C.

Table 11.4 summarizes the methods by which certain biomedical wastes are disposed of in British Columbia. The most interesting feature of this table is that the hospitals indicate that almost all of their biomedical wastes are disposed of by incineration, including most of the liquid human anatomical wastes. Sanitary sewers are reserved for a small portion of liquid human anatomical wastes, infectious biologicals and some pharmaceuticals. A small percentage of all biomedical waste categories is landfilled. It is noteworthy that the preferred option for disposing of chemical and pharmaceutical wastes is incineration, despite the fact that the hospital incinerators are not permitted to burn special wastes, a classification which would apply to most of the wastes in this category.

## TABLE 11.4

## SUMMARY OF TASK FORCE QUESTIONNAIRE SURVEY RESULTS FOR DISPOSAL METHODS BEING UTILIZED BY HOSPITALS FOR SPECIFIC WASTE STREAMS

| WASTE TYPE | DISPOSAL METHODS USED[1] | | |
|---|---|---|---|
| | Incineration | Landfill | Sewer |
| Solid human anatomical waste | 68% | 5% | |
| Liquid human anatomical waste | 54% | 6% | 14% |
| Infectious animal solids & liquid waste | 48% | 5% | |
| Infectious biological solids & liquid waste | 41% | 6% | 40% |
| Infectious nonanatomical waste | 59% | 8% | |
| Waste sharps | 81% | 8% | |
| Infectious microbiological wastes | 54% | 10% | |
| Chemical & pharmaceutical wastes | 71% | 3% | 19% |

[1] Out of 63 hospitals responding

### 11.6.2 Needs

The Task Force notes a number of needs concerning biomedical waste management technologies and practices:

1 ) Uniform guidelines and management strategies are needed for the following: biomedical waste segregation; packaging; labelling; on-site transportation and storage; pretreatment, including pretreatment discharges and emissions; off-site transportation and storage; off-site handling, such as handling at transfer stations; disposal technologies including incineration, landfilling, and sewerage; spill response; contingency planning; specific biomedical waste streams, including infectious waste, anatomical waste, sharps, pathology laboratory waste, microbiology laboratory waste, blood and blood products, and chemical and pharmaceutical wastes.

2 ) Assessment of the costs of major biomedical waste generators remaining self sufficient in their use of biomedical waste management technologies. This, for example, will include assessing the condition and the cost of upgrading existing biomedical waste incinerators.

3 ) Assessment of the need and cost of central collection, treatment, and/or disposal biomedical waste facilities for selected areas of B.C.

4 ) Development of alternatives to the present use of transfer stations for biomedical wastes in the Lower Mainland and elsewhere in B.C.

5 ) Assessment of the potential for the use of existing incinerators for the disposal of biomedical wastes.

6 ) Implementation and use of biomedical waste disposal technologies that are accessible to generators in rural as well as urban areas of B.C.

7 ) Detailed information about the availability, costs, sources of funding, and possible scheduling for implementing these technologies.

8 ) Knowledge of the impacts on handling volume requirements for biomedical waste facilities in B.C. following widespread adoption of "universal precautions".

## 11.7 LEGISLATIVE AND REGULATORY PROGRAMS AND GUIDELINES

### 11.7.1 Summary of Observations

In North America, while numerous agencies have addressed different aspects of the biomedical waste issue, no one government or agency has taken the lead in developing laws and regulations for "cradle to grave" management of biomedical wastes.

#### 11.7.1.1 Legislative and Regulatory Programs

There are a variety of biomedical waste management legislative and regulatory systems, but they do not have uniform requirements. In Canada, infectious wastes are addressed under Transportation of Dangerous Goods legislation, and in Ontario pathological wastes are specifically embodied in Environmental Legislation.

In the United states, there is no national legislation for biomedical waste. However, 8 states currently have legislation, 3 states regulate it as hazardous waste, and 13 states have issued draft regulations. Specific legislative controls in the United States are highlighted in Table 11.5. From this table it is apparent that the management of sharps takes highest priority, and that 80% of States addressing the issue require pretreatment of infectious waste before landfilling. A significant number exempt biomedical wastes from the need for pretreatment before disposal to sanitary sewer.

In British Columbia, special biomedical wastess are currently regulated under the B.C. Waste Management Act's Special Waste Regulation, but the whole range of biomedical wastes is not addressed. The Task Force has observed that a number of biomedical waste streams qualify as special wastes, but are likely currently being disposed of into sanitary landfills or sewer systems, contrary to the requirement of Section 39 of the Special Waste Regulation.

The disposal of some biomedical wastes is also governed by municipal or regional government bylaws and in some cases the requirements are very stringent.

#### 11.7.1.2 Stakeholder Agency Guidelines

Numerous guides have been published for biomedical wastes and specific parts of the biomedical waste stream such as antineoplastic drugs, AIDs wastes, and recombinant DNA. However, although the guidelines for the specific waste streams are usually consistent with one another, those for general biomedical wastes are not.

The Task Force has concluded that national guidelines for biotechnology and recombinant DNA work, such as those from the Medical Research Council (MRC), do not comprehensively address the off-site disposal of biomedical wastes. In addition, even with the Canadian Standards Association (CSA) standard "Handling of Waste Materials within Health Care Facilities", there are no broad national guidelines addressing all phases of biomedical waste management in Canada. These CSA standards resemble those published by the United States Environmental Protection Agency.

The CSA guidelines are quite comprehensive and supportable, and could be adopted with a few minor modifications addressing the following features:

1 ) They do not address off-site biomedical waste management practices thoroughly, and on-site disposal and treatment is not addressed thoroughly. They appear designed more for the protection of workers in health care facilities, than the public, the environment, or disposal workers.

2 ) Blood, blood products, and body fluid wastes are not well classified and managed.

3 ) A method to identify the status of biomedical wastes that have been rendered non-infectious by pretreatment is not provided.

4 ) The waste categories are not identical to those used by the Task Force.

5 ) They recommend that filled sharps containers and pharmaceutical wastes (excluding cytotoxics) slated for disposal be enclosed in dark green or black plastic bags, which can be indistinguishable from typical refuse bags.

6 ) Recommendations for recombinant DNA and biotechnology wastes are absent.

## TABLE 11.5

## AMERICAN LEGISLATIVE CONTROLS FOR BIOMEDICAL WASTES

| TYPE OF BIOMEDICAL WASTE CONTROL | NUMBER OF STATES |
|---|---|
| Segregation requirements | 12 |
| On-site storage requirements | 19 |
| Packaging requirements | 19 |
| Special sharps containers | 21 |
| Pretreatment of landfilled waste required | 18 |
| No pretreatment before landfilling needed | 5 |
| Human tissues only buried, incinerated, cremated | 9 |
| Discharge of untreated liquids to sewer permitted | 10 |
| Treatment and disposal required onsite | 3 |

### 11.7.2 Needs

The Task Force has noted a number of needs concerning legislation, regulation and guidelines for biomedical waste management. Generally it is observed that a set of uniform rules for the control of all phases of biomedical waste management is needed; however, whether they should take the form of guidelines, regulations or some other form has not been established. The following needs have been identified:

1 ) Review of definition of biomedical waste under the Transportation of Dangerous Goods Act.

The goal here is to create a uniform definition that can be applied federally, provincially, and municipally. While the Transportation of Dangerous Goods Regulations' definition for infectious waste is currently being reviewed, because it will apply solely to transportation of these wastes, a broader uniform definition is nevertheless required.

2 ) Uniform rules for management of biomedical wastes, including packaging; labelling; handling; in-house storage, transport and disposal; pretreatment, and off-site storage, transport, and disposal.

3 ) Uniform rules for specific biomedical waste management technologies, for example, incineration emission guidelines.

4 ) The rules should make a range of waste management options available to biomedical waste generators, handlers, carriers, and receivers.

5 ) A method of enforcing these rules needs to be implemented, in the event that compliance is poor if they are adopted as guidelines.

## 11.8 REGULATORY AGENCY ADMINISTRATION

### 11.8.1 Summary of Observations

Regulatory agencies at all levels of government in British Columbia are facing the issue of biomedical waste management. Where there have been acute problems, short-term solutions have been developed and implemented, and where the goal is to develop long-term solutions, regulatory authorities have participated in biomedical waste initiatives at the Provincial and National level.

One anomaly in the Provincial administration of biomedical wastes is evident with the Cremation Act, which requires certification of a crematorium by the chief engineer from the Ministry of Transportation and Highways. This Ministry's mandate does not involve criteria for incineration design, operation and emissions.

### 11.8.2 Needs

Since regulatory agencies are now addressing biomedical waste issues through both short- and long-term strategies, at this time there seems little need for additional administrative programs. However, if biomedical waste legislation is implemented, the needs for resources to administer and enforce the legislation will have to be considered.

Regarding the administration of the Cremation Act, there is a legislative requirement for crematoria to be certified by an engineer, but there is a need to examine the appropriateness of the currently designated certification agency, the Ministry of Transportation and Highways. Alternative agencies with good incineration engineering expertise could also be considered.

# 12.0 BIOMEDICAL WASTE MANAGEMENT STRATEGIES AND RECOMMENDATIONS

## 12.1 INTRODUCTION

The management strategies and recommendations presented in this chapter are based on medical, environmental and technical assessments of the various management practices available for biomedical wastes. In presenting these strategies and recommendations, the Task Force recognizes that additional factors such as economic, institutional, legal, political and perceptual perspectives will also have important impacts on the decision making process.

The Task Force's strategies and recommendations for the management of biomedical wastes are guided by by several principles. First, the Task Force was encouraged to develop broad strategies for biomedical waste management in the Province, rather than detailed recommendations.

Second, the Task Force recognized that biomedical wastes are a concern to many jurisdictions in North America, and in Canada some control programs are already underway or being developed Nationally. The Task Force favours the adoption of control programs for biomedical wastes that are consistent with those existing or forthcoming in this country.

Third, it was recognized that the development of detailed National control programs for biomedical wastes could take years, and that interim solutions are needed. Thus, the Task Force has considered both short and long-term biomedical waste strategies.

Fourth, the last of the Task Force's Terms of Reference calls for recommendations for a biomedical waste management system for the whole Province. Although a main stimulus for the Task Force's creation involved biomedical waste management problems in the Lower Mainland, the Task Force was given the responsibility of recommending actions that were applicable to all the Province, including large, and small centres. The following attempts to address this need.

Fifth, the option of exporting biomedical wastes for disposal outside of British Columbia may not always be available. Accordingly, the Task Force strove to identify waste disposal options that could be adopted within the Province.

Sixth, in discussing the management strategies identified by the Task force, it was decided that the null option, where a need would be addressed by the status quo, would usually not be considered because the status quo is usually not acceptable.

Finally, although the Task Force received a wide range of opinions, stakeholders consistently indicated that a system is required to improve on the existing biomedical waste situation in British Columbia. The stakeholders are looking to government for leadership in creating this system.

## 12.2 DEFINITION AND CLASSIFICATION OF BIOMEDICAL WASTE

### 12.2.1 Management Strategies

Four strategies for dealing with the need for a uniform definition for biomedical wastes follow:

- Encourage development of a National definition through the Canadian Council of Resource and Environment Ministers (CCREM) and Transport Canada.

  Both CCREM and Transport Canada, in conjunction with the Provinces, are developing definitions for biomedical wastes. A new Transport Canada definition is expected to be embodied in the Transportation of Dangerous Goods Regulations soon, to replace the existing definition for infectious wastes, while the CCREM definition is anticipated to be available in several years.

- Encourage agencies and organizations that develop standards and guidelines for biomedical waste management to develop definitions consistent with one another.

  Organizations such as the Canadian Standards Association and the Canadian Red Cross Society have developed guidelines and procedures on their own initiative to address various phases of biomedical waste management. In the absence or presence of Provincial or National biomedical waste definitions from government regulatory agencies, such organizations could be approached to encourage the adoption of consistent definitions.

- Develop a British Columbia definition for biomedical waste for interim use by all Provincial levels of government until a National consensus on a definition is achieved.

  It could take years, rather than months for a National definition for biomedical waste to be developed. Because of the pressing need for these wastes to be better addressed in B.C., Provincial regulatory agencies may wish to place a high priority on this activity. Furthermore, city, municipal, and regional governments should be encouraged to amend bylaw terminologies to correspond to any Provincial definitions adopted or developed, to reduce conflict over definitions.

- Create a new category of "special biomedical wastes" whose components require treatment as if they were infectious. This category would consist of types and sources of biomedical wastes that are, or are expected to be sufficiently infectious or noxious that they should be handled in a special manner. The following list of sources and types comes from the United States Environmental Protection Agency and is reasonably comprehensive:

  1 ) isolation wastes - includes, for example, wastes from patients placed in isolation for reasons other than protection or reverse isolation, as laid out in the CDC guidelines for isolation precautions.

  2 ) waste cultures and stocks of infectious agents and associated biologicals - includes, for example, specimens from medical and pathology laboratories; cultures and stocks of infectious agents from clinical, research, and industrial laboratories; wastes from the production of biologicals; disposable culture

dishes, and devices used to transfer, inoculate, and mix cultures; and discarded live and attenuated vaccines.

3 ) waste human blood and blood products - includes, for example, waste blood, serum, plasma and blood products.

4 ) wastes from surgeries and autopsies performed on patients and animals - includes, for example, tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy.

5 ) wastes from patients and animals known to be infected by blood-borne diseases - includes, for example, equipment from surgery, autopsy, laboratories, dialysis units, and other material contaminated from care of patients with diseases such as AIDs and hepatitis B.

6 ) waste sharps - includes, for example, broken glass, hypodermic needles, and other sharp wastes, whether infectious or not.

7 ) waste contaminated animal carcasses, body parts, and bedding - includes, for example, animal carcasses, body parts and bedding of animals intentionally exposed to infectious organisms in research, in the production of biologicals or the in vivo testing of pharmaceuticals.

### 12.2.2 Recommendations

The Task Force holds that all the strategies above merit serious consideration, and therefore, recommends that they all be adopted.

- Until a National consensus on a definition is achieved, it is recommended that a biomedical waste definition for interim use in British Columbia be adopted by the Province. The Task Force recommends that the definitions in Appendix 12.1 be used, which include specific terms and waste categories.
- It is recommended that continued support be given to the Canadian Council of Resource and Environment Ministers (CCREM) and Transport Canada in their efforts to develop a National definition for biomedical wastes.
- It is recommended that agencies and organizations that develop standards and guidelines for biomedical waste management be encouraged to develop definitions for biomedical waste that are consistent with those developed Nationally. It is also recommended that city, municipal and regional government authorities be encouraged to amend bylaw definitions pertaining to biomedical wastes to achieve consistency with Provincial definitions adopted or developed.

## 12.3 HAZARDS AND IMPACTS OF BIOMEDICAL WASTE

### 12.3.1 Management Strategies

To fulfill the need for more information related to the hazards and impacts of biomedical waste, and to ensure that biomedical wastes are managed properly, two management strategies are suggested:

- Require that special biomedical wastes and waste chemicals and pharmaceuticals are managed by specific handling, treatment, and disposal methods.

- Monitor research into the hazards of biomedical wastes and their fate and impacts when disposed of and/or treated.

  The Task Force found little information on the hazards, fate and impacts of biomedical wastes once they were disposed of untreated in sewer systems or sanitary landfills. In addition, little information was found on the impact of small quantity biomedical wastes on human health and the environment. It would be useful to keep abreast of developments in this area.

### 12.3.2 Recommendations

The Task Force recommends that both the strategies above be adopted:

- Until National initiatives are complete, it is recommended that the special biomedical wastes and chemical and pharmaceutical wastes defined by the Task Force be considered as those biomedical wastes requiring special handling, treatment and disposal in British Columbia.

- It is recommended that the Province and other government agencies monitor research into the physical hazards of biomedical wastes and their fate and impacts when disposed of and/or treated.

## 12.4 NON-GOVERNMENTAL STAKEHOLDER ACTIVITIES

### 12.4.1 Management Strategies

The Task Force has identified several strategies to address the needs noted by, and related to non-governmental stakeholder activities:

- A biomedical waste management system which contains technological, administrative, regulatory, and legislative components is developed in British Columbia.

- To ensure that continued disposal requirements can be met, generators of biomedical wastes should develop contingency plans to prepare for the possibility of closure of disposal facilities or denial of access to disposal facilities.

### 12.4.2 Recommendations

The Task Force recommends that the above strategies be addressed.

- It is recommended that governments in B.C. take initiatives to ensure that adequate biomedical waste management facilities are developed in the Province.

- It is recommended that governments in B.C. develop and implement legislative, regulatory and administrative programs to control biomedical wastes.

- It is recommended that contingency plans providing alternative disposal methods for biomedical waste be developed by waste generators.

## 12.5 BIOMEDICAL WASTE INVENTORY ISSUES

### 12.5.1 Management Strategies

The option of developing a consistent definition for biomedical wastes has already been provided in section 12.2.1, and the Task Force proposes two new strategies in this section:

- Carry out biomedical waste inventory work on those sources that were not directly or properly assessed in the present study: funeral homes, crematoria, blood blanks, doctors' offices and clinics.

- Should "universal precautions" be widely adopted, further inventory work could be carried out to provide data for the sizing of potential biomedical waste management facilities.

  Although the Task Force has roughly estimated the volumes of biomedical wastes requiring treatment under full implementation of "universal precautions", more accurate estimates are required.

### 12.5.2 Recommendations

Recommendations for consistent definitions for biomedical waste have been addressed in Section 12.2.2, and the Task Force does not feel strongly that additional inventory work on biomedical wastes is required at this time. Thus, there is one recommendation in this section.

- If "universal precautions" are adopted for biomedical wastes, it is recommended that further inventory work be carried out to provide data for the sizing of potential biomedical waste management facilities. The B.C. Ministries of Health and Environment should consult closely on this issue should it develop further.

## 12.6 BIOMEDICAL WASTE MANAGEMENT TECHNOLOGIES AND PRACTICES

In preparing management strategies and recommendations for management technologies and practices for biomedical wastes, the Task Force carried out assessments of available medical, environmental, and technical information. As such, the strategies and recommendations presented in this section are based on the findings of these assessments; however, the Task Force recognizes that additional concerns relating to economical, institutional, legal, engineering, political and perceptual perspectives will play equally important roles in decision making and implementation processes.

Because of the wide range of biomedical waste management practices, a host of options are available for dealing with these wastes. In the following section, strategies and recommendations will be presented that cover specific biomedical waste streams and practices. The need for general guidelines will be discussed in subsequent parts of this chapter.

### 12.6.1 Segregation, Packaging and Labelling

#### 12.6.1.1 Management Strategies

- Segregate, package, and label biomedical wastes according to the Canadian Standards Association methodology.

  This is a guideline that is Nationally accepted, but needs to be modified to suit Provincial requirements.

- Prohibit or discourage the compaction of biomedical wastes destined for off-site treatment or disposal.

  Compaction of biomedical wastes can destroy the packaging of biomedical wastes and can increase public and worker exposure.

#### 12.6.1.2 Recommendation

- It is recommended that the Province adopt the Canadian Standards Association methodology with minor modifications, for the segregation, labelling and packaging of biomedical wastes.
- It is recommended that the compaction of packaged solid biomedical wastes destined for off-site treatment or disposal be discouraged or prohibited.

### 12.6.2 On-site Transportation and Storage

The Task Force did not investigate the on-site transportation and storage of biomedical wastes in detail. Strategies and recommendations for these aspects of biomedical waste management are addressed later in this Chapter.

### 12.6.3 Pretreatment

The need for disinfection or sterilization of a biomedical waste depends to a large extent to the ultimate disposal method chosen for that waste. These requirements are considered in detail in this chapter in later sections for disposal by sanitary sewer, incineration and sanitary landfill.

### 12.6.4 Off-site Transportation

#### 12.6.4.1 Management Strategies

- Continue managing the transport of biomedical wastes as special wastes, by tracking shipments using a manifest system and by licensing carriers, requiring appropriate placarding and training.

  The Province currently requires that because many biomedical wastes are special wastes, the provisions of the Special Waste Regulation regarding special waste transportation apply to biomedical wastes. These provisions include shipment manifests, training, placarding and licensing, some of which are Nationally uniform. This strategy calls for the continuation of this practice.

#### 12.6.4.2 Recommendations

- Insofar as they apply to off-site transportation, it is recommended that the Province continue its present controls of biomedical wastes as special wastes through the Special Waste Regulation.

### 12.6.5 Use of Transfer Stations and Staging Areas

#### 12.6.5.1 Management Strategies

- Where permitted under any contractual provisions, dedicate specific, secure areas of transfer stations or collection depots for handling approved biomedical wastes.

  For this option to work well, diligence in assuring that inappropriate biomedical wastes such as sharps, and human anatomical waste are not accepted and mixed with the normal refuse stream. Adequate training of generators, the public, and waste management staff would be required, and attention to specific needs for contingency plans, special equipment and government permits provided.

- Phase out the use of transfer stations for compacting biomedical wastes before disposal to landfill or incineration and haul biomedical wastes directly to the landfill or use alternate disposal methods.

  The status quo, where biomedical wastes sometimes are not segregated properly at source can be perceived as posing an unacceptable hazard to workers a a solid waste transfer station. This strategy will bypass the facility, and will minimize the chance for exposure of transfer station employees and the public to biomedical wastes by minimizing the handling of these wastes.

#### 12.6.5.2 Recommendations

The recommendations for the use of transfer stations for biomedical waste management address both these strategies.

- Concerning their suitability for biomedical wastes, it is recommended that waste transfer stations and/or collection depots be used only as collection or staging areas. Biomedical waste should not be compacted at these facilities, in order to preserve the integrity of packaging.

- Should biomedical wastes be properly segregated, packaged, and labelled, and handled at transfer stations, to help avoid misperception of the risks of managing biomedical wastes, it is recommended that consideration be given to dedicating specific transfer station areas, and perhaps times, for transferring biomedical wastes. Adequate training of transfer station staff should be provided and consideration given to needs for contingency plans, government permits, and special equipment.

- In the event that biomedical wastes are not properly segregated from the normal refuse stream, it is recommended that the use of transfer stations for biomedical wastes before final disposal be stopped. These wastes should be taken directly to a disposal facility from source, until adequate segregation is achieved or alternate arrangements to handle biomedical wastes at the transfer station are arranged.

## 12.6.6 Central Disposal Facilities

### 12.6.6.1 Management Strategies

- An indepth analysis of the options, costs, availability, and acceptability of centralized biomedical waste treatment, collection, and disposal facilities could be carried out.

  While the Task Force has identified various options for central biomedical waste management facilities, it has not performed a detailed analysis of the topic. This could be carried out in the private sector or by regional governments, as the need arises, and this would include consideration of existing and planned facilities capable of properly disposing of biomedical wastes. The B.C. Ministry of Regional Development may have an interest in this issue.

### 12.6.6.2 Recommendations

The Task Force agrees that the possibility of developing central biomedical waste management facilities deserves careful scrutiny.

- It is recommended that as appropriate, feasibility studies, providing an indepth analysis of the options, costs, availability, and acceptability of centralized biomedical waste treatment, collection, and disposal facilities be carried out for high population areas of the Province. The allocation of responsibility for this project between the Province, regional governments, and the private sector should be determined.

## 12.6.7 Incineration

### 12.6.7.1 Management Strategies

- Immediately charge an ad hoc working group with the responsibility of developing discharge, design, and operating criteria for biomedical waste incinerators.

  The output of this option has been repeatedly requested by those responsible fo biomedical waste incinerators in B.C.

- Assess the costs of upgrading existing biomedical waste incinerators to meet National and Provincial discharge guidelines, when the guidelines become available.

  This is a major project, and was regarded as beyond the capabilities of the Task Force.

- Assess the potential of existing or planned incinerators to dispose of biomedical wastes.

Incinerators such as 1) the GVRD facility in Burnaby and 2) the rotary kiln proposed by B.C. Special Waste Services Ltd. for special wastes are technically capable of destroying biomedical wastes adequately, and providing both pretreatment and disposal capabilities.

#### 12.6.7.2 Recommendations

The Task Force suggests that all the above management strategies be adopted.

- It is recommended that an ad hoc working group be struck to develop criteria for discharges, design, and operation of biomedical waste incinerators in British Columbia.

- It is recommended that the costs of upgrading existing biomedical waste incinerators to meet any new National or Provincial discharge guidelines be determined.

- It is recommended that the potential of existing or planned incinerators in the Province to dispose of biomedical wastes be studied.

- It is recommended that the incineration of all categories of biomedical wastes identified by the Task Force be regarded as acceptable, with the proviso that pure liquid biomedical wastes are not burned and that the incinerators are capable of and operated so they properly destroy each waste type.

### 12.6.8 Sanitary Landfill Disposal

#### 12.6.8.1 Management Strategies

- Permit landfilling of all categories of biomedical wastes in untreated form.

  This strategy does not take into account various problems with landfilling particular biomedical waste streams. The problems include aesthetic impacts of landfilling human anatomical wastes; unacceptable human and environmental impacts of landfilling chemical and pharmaceutical wastes; injury from sharps and threats of spread of disease from landfilling infectious biomedical wastes. Where municipal landfills are used by the public, this approach incurs some of the same problems on transfer stations.

- Manage special biomedical wastes, and chemicals and pharmaceuticals separately, while permitting landfilling of the remainder.

  This strategy takes into account most of the problems associated with landfilling biomedical wastes as long as the wastes are properly segregated. Some biomedical waste generators have had difficulty in achieving good biomedical waste segregation.

- Require landfilled infectious waste to be covered immediately or daily.

  The use of specified cover procedures will provide security from access to biomedical wastes by scavengers and will minimize exposure of workers to the wastes. As long as infectious wastes have been excluded from the biomedical waste stream, immediate or daily covering should not be necessary from a public or occupational health perspective. Nevertheless, they will have merit based on aesthetic concerns, because they will keep biomedical wastes out of sight of the public, workers and scavengers.

- Require infectious waste to be contained in a separate permitted sanitary landfill cell.

  Landfilling biomedical wastes in a separate landfill cell will permit easy management of the wastes should monitoring reveal problems with air emissions, contaminated leachate, etc. and will also minimize exposure to workers and the public. It will increase disposal costs.

#### 12.6.8.2 Recommendations

The Task Force has carried out a detailed analysis of the landfill disposal options for each biomedical waste category. The recommendations below were developed mainly from consideration of the potential physical impacts on human health and the environment. Since problems concerning perception of biomedical wastes when disposed of in sanitary landfills can arise, it was decided that this issue could be addressed by requiring immediate cover of all biomedical wastes disposed of to sanitary landfill. The following recommendations are medically and environmentally acceptable, but subject to necessary changes in municipal and Provincial legislation.

- It is recommended that the sanitary landfill disposal of 1) special biomedical waste that has not been pretreated and 2) waste chemicals and pharmaceuticals be considered unacceptable. Sanitary landfill disposal of solid special biomedical waste that has been sterilized or disinfected should be considered acceptable, provided that sharps have been: 1) blunted or ground and then pretreated or 2) solidified and that human anatomical waste is excluded. The remaining solid infectious wastes which do not include special biomedical wastes, should not require pretreatment before sanitary landfill disposal. A summary of the Task Force's recommendations on sanitary landfill disposal of biomedical waste is shown in Table 12.1.

- It is recommended that all biomedical wastes that are disposed of in a sanitary landfill, irrespective of their pretreatment status, be covered immediately following disposal.

This practice will take biomedical wastes out of immediate view of workers and the public at sanitary landfills, so will help to minimize perception problems associated with biomedical waste landfill disposal, and also reduces access to scavengers. Consideration could also be given to providing a segregated landfill area for biomedical waste.

### 12.6.9 Sanitary Sewer Disposal

#### 12.6.9.1 Management Strategies

- Sterilize or disinfect all liquid infectious wastes before disposal to sanitary sewers.

  This strategy would require significant improvements to sewage collection systems at biomedical waste facilities.

## TABLE 12.1

## CATEGORIES OF BIOMEDICAL WASTE THAT MAY ACCEPTABLY BE DISPOSED OF IN PERMITTED SANITARY LANDFILLS

| Waste Category | Biomedical Waste Pretreatment Status | |
|---|---|---|
| | Pretreated | Not Pretreated |
| 1. Solid human anatomical waste | unsuitable[1] | unsuitable |
| 2. Liquid human anatomical waste | unsuitable | unsuitable |
| 3. Infectious animal waste (solid) | acceptable[2,3] | unsuitable |
| 4. Infectious biological waste (solid) | acceptable[3] | unsuitable |
| 5. Infectious non-anatomical waste (solid) | acceptable[3] | unsuitable |
| 6. Waste sharps | acceptable[4] | unsuitable |
| 7. Infectious microbiological waste (solid) | acceptable[5] | unsuitable |
| 8. Chemical and pharmaceutical wastes | unsuitable | unsuitable |

[1] Unsuitable means the option is not appropriate from the standpoint of aesthetics, public health or the environment; the waste is liquid; or that the waste should be pretreated by sterilization or disinfection.

[2] Acceptable means sanitary landfill disposal is one of the methods that could be used to dispose of the waste stream properly from a public health and environmental prospective, where laws, regulations, permit, bylaws and other considerations allow.

[3] Solid special biomedical wastes may be landfilled if they are pretreated by sterilization or disinfection.

[4] Sharps that have been 1) blunted or ground and then disinfected or sterilized, or 2) solidified, may be landfilled.

[5] Sterilization is the preferred method of pretreatment.

- Discharge untreated biomedical wastes to the sanitary sewer system with the exception of sterilizing or disinfecting liquid biomedical wastes.

  This strategy is close to the status quo.

- Discharge all liquid biomedical wastes untreated to sanitary sewers.

  This strategy involves adopting practices for biomedical wastes that are less stringent than those already followed.

#### 12.6.9.2 Recommendations

The recommendation below was developed solely from consideration of the potential physical impacts on human health and the environment. Since problems concerning perception of biomedical wastes when disposed of in sanitary sewer systems do not appear serious, it was decided that this issue need not be addressed by requiring pretreatment of all biomedical wastes disposed of to sanitary sewer. This recommendation is medically and environmentally acceptable, but subject to necessary changes in municipal and Provincial legislation.

- It is recommended that certain biomedical wastes may be disposed of in sanitary sewer systems. All liquid infectious biomedical wastes may be discharged to sanitary sewers without pretreatment, with the exception of liquid special biomedical wastes. The remaining infectious liquid wastes, which do not include liquid special biomedical wastes generally, may be discharged to sanitary sewer without pretreatment. Waste chemicals and pharmaceuticals generally should not be discharged to sanitary sewer. A summary of the Task Force's recommendations on sanitary sewer disposal of biomedical waste is shown in Table 12.2.

### 12.6.10 Disposal of Specific Biomedical Waste Categories

#### 12.6.10.1 Management Strategies

It is useful to consider the disposal options for the specific biomedical waste categories identified by the Task Force, separately from an analysis of particular disposal methods.

General Considerations for Infectious Waste

Since many of the biomedical waste categories relate to infectious wastes, before addressing each category separately, broad options for this type of waste will be considered first.

- Incinerate or dispose of infectious wastes to sanitary sewers or landfills in unsterilized or undisinfected form.

  This option represents regression from the status quo, because many wastes, such as microbiology and pathology laboratory wastes are presently sterilized before disposal to landfills. Currently, of those biomedical wastes that are incinerated in British Columbia, most if not all are not pretreated; of those that are disposed of in sanitary sewers, most, with the exception of liquid human anatomical wastes infected with the AIDs virus, are disposed of untreated; and of those that are landfilled, an unknown proportion is pretreated.

## TABLE 12.2

## CATEGORIES OF BIOMEDICAL WASTE THAT MAY ACCEPTABLY BE DISPOSED OF IN SANITARY SEWER SYSTEMS

| Waste Category | Biomedical Waste Pretreatment Status | |
|---|---|---|
| | Pretreated | Not Pretreated |
| 1. Solid human anatomical waste | unsuitable[1] | unsuitable |
| 2. Liquid human anatomical waste | acceptable | acceptable[2,3] |
| 3. Infectious animal waste (liquid) | acceptable | acceptable[3] |
| 4. Infectious biological waste (liquid) | acceptable | acceptable[3] |
| 5. Infectious non-anatomical waste (liquid) | unsuitable | unsuitable |
| 6. Waste sharps | unsuitable[4] | unsuitable |
| 7. Infectious microbiological waste (liquid) | acceptable[5] | unsuitable |
| 8. Chemical and pharmaceutical wastes | unsuitable | unsuitable |

[1] Unsuitable means the option is not appropriate from the standpoint of aesthetics, public health or the environment; the waste is solid; or that the waste should be pretreated before disposal by sterilization or disinfection.

[2] Acceptable means sanitary sewer disposal is one of the methods that could be used to dispose of the waste stream properly from a public health and environmental perspective, where laws, regulations, permits and bylaws allow.

[3] Liquid special biomedical waste must be sterilized or disinfected before disposal to a sanitary sewer, with the exception of liquid isolation wastes and non-AIDs contaminated blood and blood products.

[4] Liquids from ground and disinfected sharps may be disposed of in sanitary sewer.

[5] Sterilization is the preferred pretreatment option.

- Sterilize and/or disinfect all special biomedical wastes before disposal to sanitary sewer or landfill.

  This option involves increasing controls on biomedical waste disposal. Currently, usually only infectious solid wastes are sterilized or disinfected at hospitals, the largest source of biomedical wastes in the Province. While disinfection or sterilization of all biomedical wastes may not be regarded as necessary from a medical standpoint, it may still be expedient to provide infectious solid, or all infectious wastes this standard of care.

- Sterilize and/or disinfect infectious wastes before disposal to sanitary sewer or landfill.

  This option represents the standard of care presently provided to many infectious wastes.

### Solid Human Anatomical Waste

The only acceptable disposal option for human anatomical waste is, and has been incineration, for aesthetic reasons. Disposal of human body parts to sewer systems or landfills is perceived as unsuitable and unacceptable because it does not show proper respect. Cremation and interment are not considered here to be disposal methods.

### Liquid Human Anatomical Waste

The disposal of liquid human anatomical wastes is normally not achieved by incineration or landfilling, because the former is usually reserved for solids or non-aqueous liquids, while the latter for solids. Usually noninfectious and infectious liquid human anatomical wastes are disposed of untreated in sewer systems, with the exception of AIDs contaminated blood and blood products, and a few of the other infectious biomedical wastes. Nevertheless, incineration can be used if deemed necessary or convenient.

### Infectious Animal Waste

Unless it falls into the special biomedical waste category, an infectious animal waste could be landfilled or incinerated if it is a solid anatomical waste, or disposed of to a sanitary sewer system or in a proper incinerator if it is a liquid waste, municipal bylaws and Provincial regulations permitting.

### Infectious Biological Wastes

Since biological wastes can be considered liquids, these could usually be disposed of to sanitary sewer systems as long as the practice is consistent with prevailing laws and regulations.

### Infectious Non-anatomical Wastes

These wastes, which include contaminated equipment and clothing, are normally not a significant concern, unless they fall in the special biomedical waste category. Usually they could be landfilled or incinerated.

### Waste Sharps

- Devise a specific management strategy for sharps that is accessible to all generators, from individual doctors and other sharps generators, to large institutions.

- Ensure that waste sharps are disinfected or sterilized before disposal to a sanitary landfill.

- Require that waste sharps be immobilized and landfilled or destroyed by high temperature incineration or grinding.

  The disposal of sharps has been a major focus of many biomedical waste stakeholders in British Columbia and elsewhere. The status quo, where the management of sharps is not well controlled except voluntarily by biomedical waste generators, is known to give rise to injuries and occasional infections in waste handlers. Both landfill disposal and incineration can be used to dispose of these wastes; however, the need and ability of standard treatment methods to render them sterile through autoclaving or disinfected through chemical treatment, before landfilling, is uncertain.

### Infectious Microbiological Waste

Because these wastes, which come from human and animal surgeries and microbiology, pathology and research laboratories are often highly infective, the option normally practiced is to sterilize these wastes before disposal. Alternately they can be incinerated. Any other option for handling these types of wastes, such as disposal to landfill or sanitary sewer without pretreatment, would reduce the care provided and create greater risk to human health and the environment.

### Chemical and Pharmaceutical Waste

- Develop disposal guidelines, such as maximum quantities that could be disposed of in a sanitary sewer system.

  Although significant quantities of unmetabolized pharmaceuticals and chemicals end up in sanitary sewer systems, under existing law in British Columbia, these wastes can qualify as special wastes, and usually should be handled as such. However, for small quantities of chemicals and pharmaceuticals, these wastes may be exempt from a number of special waste requirements. Since many municipal bylaws forbid this practice, a review and possible bylaw amendments may be warranted.

- Encourage the development of systems to ensure that waste pharmaceuticals are collected from patients, clinics, physicians, and pharmacies and properly disposed of, returned to the manufacturer, or otherwise recycled.

  The Task Force was made aware of the need for systems to collect and dispose of waste pharmaceuticals from various sources. The current system of Regional Special Waste Storage Facilities does not have sufficient capacity to meet their need.

- Continue regulating chemical and pharmaceutical waste as special wastes under the Provincial Special Waste Regulation.

  The Special Waste Regulation offers strict controls for the management of all types of chemical wastes, and is a workable method to control waste chemicals and pharmaceuticals from biomedical waste generators.

Blood, Blood Products and Other Bodily Fluids

- Dispose of noninfectious blood and blood products in a sanitary sewer system.

- Dispose of infectious blood and blood products after disinfection or sterilization.

  The options for dealing with infectious and noninfectious blood and blood products were discussed in the general preamble to this section on dealing with infectious wastes. While blood and blood products are normally regarded as sterile, for aesthetic reasons small quantities could be disposed of carefully in a sanitary sewer system, if permitted by law. Infectious blood and blood products are sometimes sterilized or disinfected before disposal to sewer systems. At other times, without pretreatment, infectious blood and blood products are disposed of to sanitary sewer, apparently with little observed adverse impact.

Recombinant DNA and Biotechnology Wastes

- Encourage, monitor, and participate in the development of National and International initiatives to control recombinant DNA and biotechnology wastes.

  The Task Force has not investigated this topic in detail, but feels it is important to keep abreast and to ensure appropriate controls are in place.

### 12.6.10.2 Recommendations

The current methods of disposing of several of the biomedical waste categories, such as human solid, anatomical waste, liquid human anatomical waste, seems acceptable to the Task Force and will not be further considered here. Nevertheless, for the sake of emphasis and clarity or to indicate that a need requires attention, the Task Force has recommendations for the biomedical waste categories that follow. These recommendations reflect concerns for protecting human health and the environment, and do not reflect economic, political, perceptual, and legal considerations.

Contaminated Solid Animal Anatomical Waste

- It is recommended that a review be carried out on the practices of using solid animal anatomical waste contaminated with pharmaceuticals or infectious organisms for animal feed, fertilizer or in rendering plants.

Waste Sharps

- It is recommended that a specific management strategy for waste sharps that is accessible to various types of generators, from individual doctors and sharps generators, to large institutions, be devised and implemented. This strategy may involve various collection, storage, treatment, and disposal options.

- Before disposal to a sanitary landfill, It is recommended that waste sharps be immobilized by solidification or destroyed by incineration, or grinding and disinfection.

Chemical and Pharmaceutical Waste

- It is recommended that disposal guidelines for small quantities of pharmaceuticals and chemicals from biomedical wastes generators be developed.
- It is recommended that the Waste Management Act's Special Waste Regulation continue to apply to waste pharmaceuticals and chemicals.
- It is recommended that specific systems to handle waste pharmaceuticals from patients, doctors, pharmacies, and clinics be developed. Collection, return, and disposal methods should be considered. Return of waste pharmaceuticals and recycling of chemicals should be encouraged.

Blood, Blood Products and Other Bodily Fluids

- It is recommended that the disposal of small quantities of non-infectious blood, blood products and other bodily fluids to sanitary sewer systems be legally permitted. Sanitary sewer disposal of specified infectious blood and blood products, should be permitted after disinfection or sterilization.

Infectious Non-Anatomical Wastes

- As long as they do not qualify as special biomedical wastes, it is recommended that non-anatomical wastes may be disposed of without pretreatment.

Recombinant DNA and Biotechnology Wastes

- It is recommended that the Province should encourage National and International initiatives to develop controls for wastes from recombinant DNA and biotechnology activities, and keep abreast of developments in this field.

## 12.7 LEGISLATIVE AND REGULATORY PROGRAMS AND GUIDELINES

### 12.7.1 Management Strategies

- Encourage Transport Canada to continue to revise its biomedical waste definition.

  Since Transport Canada is already reviewing its definition for infectious waste, and since the Province has had input into the revisions required, there is little more need to be done on this issue.

- Encourage the Canadian Council of Resource and Environment Ministers (CCREM) to develop uniform National guidelines for adoption by provinces for on- and off-site biomedical waste issues.

  The Province has a member on the National CCREM Steering Committee for developing National guidelines for all aspects of biomedical waste management. The needs identified by the Task Force can be communicated nationally through this representative. It is anticipated that it will take several years before these guidelines are developed.

- Develop and implement Provincial guidelines for biomedical wastes.

  In the several year period that National biomedical waste guidelines are being developed, the Province may wish to develop and adopt its own interim guidelines to cover biomedical waste issues that need immediate attention in British Columbia.

- Adopt CSA guidelines as Provincial policy, and supplement with specific modifications and additions to address problems discussed previously.

  The CSA guidelines are Nationally accepted standards for the in-house management of biomedical wastes in health care facilities. These guidelines could be expanded to address the issues requiring additional attention: animal biomedical wastes; blood, blood products, and bodily fluids; off-site biomedical waste handling, treatment, and disposal; and labelling of treated biomedical wastes,. They could be adopted Provincially, until National guidelines are available.

- Develop and implement Provincial health, environment and transportation Ministry legislation and regulations for biomedical wastes.

  In the event that Provincial guidelines were implemented, but were found to receive poor compliance, the Province could adopt them in regulatory form. Alternately, the Province could decide to implement regulatory controls without proceeding through a guidelines phase.

- Encourage the adoption of municipal bylaws for biomedical wastes consistent with Federal and Provincial legislation.

- Provide small quantity, waste type, or source exemptions.

  The Task Force has noted that a number of sources of biomedical waste are apparently not associated with significant human health or environmental impacts. Consideration could be given to limiting the application of any biomedical waste definition by providing small quantity, waste type, source or disposal method exemptions, where specific types of biomedical wastes would be exempt from specified requirements.

### 12.7.2 Recommendations

The Task Force has received an extremely strong message from stakeholders that uniform rules for biomedical waste management are needed immediately. In the interests of uniformity and in maintaining continuity, the Task Force holds that the Canadian Standards Association Standard can form a basis for these rules, and should be well accepted by stakeholders.

- It is recommended that continued support be given to the Canadian Council of Resource and Environment Ministers (CCREM) in its development of national guidelines for on- and off-site biomedical waste management practices.

- General controls for a variety of biomedical waste practices are required now in British Columbia. It is recommended that one of the following four general methods be adopted:

Method 1:

The Province should develop and implement Provincial guidelines for biomedical wastes independent of ongoing efforts to develop National biomedical waste guidelines. The Canadian Standards Association Standard "Handling of Waste Materials within Health Care Facilities" should be adopted as Provincial policy, supplemented with specific modifications to address issues requiring additional attention, for example:

1. Improve the classification and controls for blood, blood products and body fluid wastes.
2. Supplement with detailed guidance for off-site biomedical waste management.
3. Provide a means of identifying biomedical wastes that have been rendered non-infectious through sterilization or disinfection.
4. Provide alternate colour coding to that presented for filled sharps containers and pharmaceutical wastes.
5. Qualify references to preferred waste management options.
6. Provide guidance for the management of biomedical wastes from biotechnology and recombinant DNA work.

Method 2:

In the period when National guidelines for biomedical waste practices are being developed, the Province should develop and implement Provincial guidelines for biomedical wastes, as described in Method 1. In the event that compliance with the Provincial guidelines were poor the Province should frame them in regulatory form.

Method 3:

During the period of development of National guidelines for biomedical waste management, the Province should develop and implement its own guidelines for biomedical wastes, as described in Method 1. When National biomedical waste guidelines become available, the national guidelines would replace those developed previously by the Province.

Method 4:

The Province, through the Ministries of Health and Environment, should immediately develop and implement legislative and regulatory controls for biomedical waste management in British Columbia, based on the controls described in Method 1. Consideration should be given to adopting National guidelines or amending Provincial ones when the former become available.

In view of strong evidence of the failure of the present system for managing biomedical wastes, despite efforts of regulatory agencies, the Task Force favours Method 4.

## 12.8 REGULATORY AGENCY ADMINISTRATION

### 12.8.1 Management Strategies

- Supply the necessary resources for administering government biomedical waste programs as long-term programs for control of biomedical wastes are being developed and implemented.

  Should it be decided that major regulatory programs for biomedical wastes are to be implemented, then the necessary resources should be obtained.

- Transfer the legislative authority for the certification of crematoria under the Cremation Act to the Ministry of Environment.

### 12.8.2 Recommendations

The Task Force suggests that both strategies be adopted.

- It is recommended that resources to administer biomedical waste control programs be supplied by regulatory agencies as the long-term biomedical waste strategies are developed and implemented.

- It is recommended that powers to certify crematoria under the Provincial Cremation Act be transferred to the Ministry of Environment.

## 12.9 COMMUNICATIONS, INFORMATION AND TRAINING

### 12.9.1 Management Strategies

The Task Force observed the need for clearer understanding of biomedical wastes by the public and all stakeholders, and this was evident at many points during the Task Force's work. Too often persons with a stake in one part of the cycle of biomedical waste management were unaware of the needs of others handling the wastes at a different stage of the cycle. To address this issue, two strategies are proposed to enhance communication, information and training on biomedical waste.

- Prepare and disseminate fact sheets and information bulletins on biomedical waste.

  These could be prepared by different stakeholders as is required. A biomedical waste fact sheet is currently being prepared on biomedical wastes by the Canadian Council of Resource and Environment Ministers, and could be reviewed by the Ministers of Health for agreement and adoption .

- Create and implement education programs for the public, biomedical waste generators, biomedical waste handlers, and other biomedical waste stakeholders.

  This could include meetings and seminars sponsored by different agencies, to foster understanding of the issue and requirements for proper management of biomedical wastes. The Greater Vancouver Regional District has already carried out meetings with major biomedical waste generators in this context. Training programs for biomedical waste handlers are obviously required.

### 12.9.2 Recommendations

The Task Force has suggested that both strategies be adopted.

- It is recommended that information and educational materials and programs on the hazards and controls for biomedical wastes be prepared, and made available to the appropriate audiences.

# BIOMEDICAL WASTES

# IN

# BRITISH COLUMBIA

## APPENDICES TO THE REPORT OF THE BRITISH COLUMBIA TASK FORCE ON BIOMEDICAL WASTE MANAGEMENT

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Appendix 10.3 An Examination and Risk Evaluation of Infectious Waste in King County, Washington - March, 1988
Appendix 10.4 Report of the Ontario Inter-Ministry Task Force on Biomedical Waste - A Strategy for the Management of Biomedical Waste - April, 1986
Appendix 10.5 Study on the Feasibility of Establishing a Central Waste Management Facility for Biomedical Waste from the Greater Metro Toronto Area - November, 1986
Appendix 10.6 State-of-the-Art Report on the Management of Biomedical (Type A) Wastes in Canada - February, 1988
Appendix 10.7 Survey of Hospital Waste in Alberta Health Care Institutions - March, 1985
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# APPENDIX 1.0

## INTRODUCTION

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# APPENDIX 1.1

## GLOSSARY

**AIDs** - means acquired immunodeficiency syndrome.

**anatomical** - means tissues, organs, body parts, products of conception and animal carcasses, and liquids such as blood, blood products, secretions and similar body fluids.

**antineoplastics** - means agents that prevent the development, growth or proliferation of cells.

**ASHP** - means the American Society of Hospital Pharmacists.

**biological** - means solid and materials liquid from metabolic functions such as feces, urine, vomitus.

**biologicals** - means medicinal compounds that are prepared from living organisms and their products; includes serums, vaccines, antigens and antitoxins.

**CCREM** - means the Canadian Council of Resource and Environment Ministers.

**CDC** - means the U.S. Centres for Disease Control.

**CLST** - means the Canadian Society of Laboratory Technologists.

**communicable disease** - means an illness, due to a specific infectious agent or to toxic products, which arises through the transmission of that agent or its product.

**CSA** - means the Canadian Standards Association.

**CSHP** - means the Canadian Society of Hospital Pharmacists.

**dialysis** - means the process of diffusing blood across a semipermeable membrane to remove toxic materials and to maintain fluid, electrolyte, and acid-base balance in cases of impaired kidney function or absence of kidneys.

**disinfection** - means the application of chemical agents to kill bacteria.

**EPA** - means the United States Environmental Protection Agency

**etiological agents** - means agents responsible for the cause or causes of disease.

**fomites** - means any substance that may harbour or transmit pathogenic organisms.

**GVHS** - means the Greater Victoria Hospital Society.

**GVRD** - means the Greater Vancouver Regional District.

**HBV** - means hepatitis B virus.

**HIV** - means human immunodeficiency virus, which causes AIDs.

**infectious** - means being contaminated or suspected of being contaminated with the causative agents, or their toxic products, of a communicable disease, and capable of transmitting such disease to susceptible individuals or animals.

**infectious waste** (US EPA) - means waste capable of producing infectious disease.

**isolation** - means the separation, for the period of communicability of the disease, of an infected person or animal from others in a place and under conditions to prevent the conveyance of the infectious agent to those others.

**MRC** - means the Medical Research Council of Canada.

**NIH** - means the American National Institute of Health.

**OSHA** - means the Occupational Safety and Health Administration of the United States.

**parenternal** - means any route other than the oral, such as intravenous, subcutaneous, intramuscular or mucosal.

**pathological** - means all human anatomical and animal anatomical materials suspected of being infected with a disease communicable to humans or animals.

**percutaneous** - means absorbed or passing through the skin.

**pretreatment** - means sterilization or disinfection.

**PVC** - means polyvinyl chloride.

**reverse isolation** - means the separation, for the period of communicability of the disease, of a person or animal possessing inadequate resistance against specific infectious agents, from others in a place and under conditions to prevent the conveyance of the infectious agent to those individuals.

**sharps** - means needles, syringes, blades, clinical glass and any other clinical item capable of causing a cut or puncture.

**SPCA** - means the Society for the Prevention of Cruelty to Animals.

**special biomedical wastes** - means the types and sources of biomedical wastes from humans and animals that are, or are expected to be, sufficiently noxious or infectious that they should be handled, treated and disposed of in a special manner.

**sterilization** - means a process which removes or destroys all microorganisms on a substance.

**TDGA** - means the Canadian Federal Transportation of Dangerous Goods Act.

**thermolabile** - means destroyed or changed easily by heat.

**Universal Precautions** - means the policy where all human blood, blood products and body fluids are considered infectious.

**US EPA** - means the United States Environmental Protection Agency

**WHO** - means the World Health Organization.

# APPENDIX 1.2

## BRITISH COLUMBIA TASK FORCE ON BIOMEDICAL WASTE MANAGEMENT

## TERMS OF REFERENCE

The Task Force on Biomedical Waste Management has been appointed to review the following issues and make recommendations to the Ministries of Environment, and Health on actions and policies required to ensure safe and acceptable management practices for wastes coming from such facilities as medical offices, hospitals, and mortuaries in British Columbia.

The general terms of reference involve the following activities:

1. Define and classify biomedical wastes in B.C.

2. Develop an inventory of the sources, types, nature and volumes of biomedical wastes in B.C.

3. Review and evaluate methods for handling, storage, transport, treatment and disposal of biomedical wastes.

4. Review and evaluate the requirements of other jurisdictions and consider their application to biomedical waste management in B.C.

5. Recommend a management system specifically for biomedical wastes in British Columbia, including technological, legislative, regulatory, and administrative controls.

# APPENDIX 1.3

## BRITISH COLUMBIA TASK FORCE ON BIOMEDICAL WASTE MANAGEMENT

## TASK FORCE MEMBERSHIP

Formal Appointees:

Ministry of Environment

John E.H. Ward, Ph.D. (Chairperson)
D.A. Douglas, P.Eng.
K.K. Bhattacharyya, Ph.D., P.Eng.

Ministry of Health

A.G. Hazelwood
S.L. Hemming, M.B.Ch.B., F.R.C.P(C)
Neil Fatin, M.B., B.S., F.R.A.C.P., M.B.A., F.R.A.C.M.A., A.H.A.

Greater Vancouver Regional District

L.H. Hayton, P.Eng.

City of Vancouver

Brian Davies, P.Eng.

Contributing Members:

Ministry of Environment

Michael W. Macfarlane, B.Sc.

Ministry of Health

Ray Marsh, M.D.
Bob Smith

Greater Vancouver Regional District

Cristina Jacob, M.A.Sc., P.Eng.

City of Vancouver

Susan Clift, P.Eng.

# APPENDIX 2.0

## BIOMEDICAL WASTE DEFINITIONS, CLASSIFICATIONS, SOURCES, HAZARDS AND IMPACTS

PAGE

APPENDIX 2.1 WORKING DEFINITIONS AND CATEGORIES 1

# APPENDIX 2.1

## WORKING DEFINITIONS AND CATEGORIES

Biomedical wastes means those discarded materials which, due to their nature and source, categorized below, require specific treatment prior to disposal.

Biological wastes means solid and liquid wastes from human metabolic functions including feces, urine, vomitus, dialysis byproducts, and the like.

Infectious means being contaminated or suspected of being contaminated with the causative agents, or their toxic products, of a communicable disease, and capable of transmitting such disease to susceptible individuals or animals.

### Biomedical Waste Categories

1. Solid human anatomical wastes, including any body part or tissue except extracted teeth, hair, nail clippings, and the like, but excluding biological wastes.
2. Liquid human anatomical wastes such as blood products, secretions, and similar body fluids, but excluding biological wastes.
3. Infectious animal solid and liquid wastes, including carcasses, body parts, body fluids, bedding materials, and associated biological wastes.
4. Infectious biological wastes.
5. Infectious nonanatomical wastes directly associated with patient care such as bandages, gowns, masks, gloves, tubing, and similar equipment.
6. Waste sharps including hypodermic needles, syringes, scalpel blades, pasteur pipettes, and broken glass.
7. Infectious microbiological wastes including serums, vaccines, cultures, and stock used in clinical, research and industrial applications, and their associated fomites.
8. Chemical and pharmaceutical wastes including antineoplastics and associated fomites.

# APPENDIX 3.0

## SURVEY OF NON-GOVERNMENT STAKEHOLDER ACTIVITIES AND NEEDS

PAGE

APPENDIX 3.1 LIST OF NON-GOVERNMENT STAKEHOLDERS INVITED TO MEET WITH THE TASK FORCE 1

## APPENDIX 3.1

## LIST OF NON-GOVERNMENT STAKEHOLDERS INVITED TO MEET WITH THE TASK FORCE

College of Dental Surgeons of B.C.

College of Family Physicians of Canada
B.C. Chapter

College of Pharmacists of British Columbia

College of Physicians and Surgeons of B.C.

B.C. Funeral Services Association

B.C. Health Association

B.C. Long Term Care Association

B.C. Medical Association

B.C. Veterinary Medical Association

B.C. Association of Private Care Facilities

Registered Nurses' Association of B.C.

Clinical Laboratory Management Association
B.C. Chapter

Hospital Administrators Association of B.C.

Society for the Prevention of Cruelty
to Animals

BFI Waste Systems

Laidlaw Waste Systems Limited

Dewdney-Alouette Regional District

East Kootenay Regional District

Fraser-Cheam Regional District

Fraser-Fort George Regional District

Envirochem Services

Kitimat-Stikine Regional District

Kootenay Boundary Regional District

Mount Waddington Regional District

Nanaimo Regional District

Red Cross Canada
B.C. - Yukon Division

B.C. Association of Laboratory Physicians

Metropolitan Clinical Laboratories Ltd.

B.C. Bio-Medical Laboratories Ltd.

Union of B.C. Municipalities

Governmental Refuse Collection and Disposal
Association

Alberni-Clayoquot Regional District

Bulkley-Nechako Regional District

Capital Regional District

Cariboo Regional District

Central Coast Regional District

Central Fraser Valley Regional District

Central Kootenay Regional District

Central Okanagan Regional District

Columbia-Shuswap Regional District

Comox-Strathcona Regional District

Cowichan Valley Regional District

North Okanagan Regional District

Okanagan-Similkameen Regional District

Peace River Regional District

Powell River Regional District

Skeena-Queen Charlotte Regional District

Squamish-Lillooet Regional District

Sunshine Coast Regional District

Thompson-Nicola Regional District

B.C. Special Waste Advisory Committee

Lions Gate Hospital

Saanich Peninsula General Hospital

# APPENDIX 4.0

## TASK FORCE QUESTIONNAIRE SURVEY

APPENDIX 4.1 TASK FORCE QUESTIONNAIRES
APPENDIX 4.2 GENERAL HOSPITAL FACILITY INFORMATION
APPENDIX 4.3 DISPOSAL METHODS USED FOR VARIOUS WASTE CATEGORIES
APPENDIX 4.4 SEGREGATION AND PACKAGING OF BIOMEDICAL WASTES
APPENDIX 4.5 INCINERATOR DATA FOR HOSPITALS

# APPENDIX 4.1

# TASK FORCE QUESTIONNAIRES

# BIOMEDICAL WASTE - QUESTIONNAIRE

## SECTION 1:

==========================================================================

NAME OF HOSPITAL/INSTITUTION: ............................................

ADDRESS OF INSTITUTION: ............................................

............................................

DISTRICT: ............................................

NUMBER OF BEDS [IF HOSPITAL]: ...........

OR

SIZE AND DESCRIPTION OF ORGANISATION: ............................................

............................................

==========================================================================

## SECTION 2:

## PRELIMINARY INFORMATION:

The following definitions have been derived from multiple juridictions in North America, including the Canadian Standards Association, and for the purposes of the Questionnaire they have been adopted to provide some degree of consistency in interpretation and reporting.

Biomedical Wastes are those discarded materials which due to their nature and generating source, categorised below, require special treatment prior to disposal.

Infectious Wastes are defined as being contaminated or suspected of being contaminated with the causative agents, or their toxic products, of a communicable disease, and capable of transmitting such disease to susceptible individuals or animals.

Biological Wastes are defined as solid and liquid wastes from human metabolic functions, including faeces, urine, vomitus, dialysis by-products and the like.

Generating Sources:

- Hospitals
- Doctors’Clinics
- Mortuaries and Funeral Homes
- Coroner Offices
- Blood Banks
- Crematoria
- Community Health Care Facilities
- Dentists, Orth- & Peri-Odontists
- Laboratories [Clinical & Research]
- Veterinary & Animal Care Facilities
- Pharmaceutical Suppliers

Waste Categories:

1. Solid Human Anatomical - including any body part except extracted teeth, hair, nail clippings and the like, but excluding biological wastes

2. Liquid Human Anatomical Waste - such as blood products, secretions and similar body fluids - but excluding biological wastes.

3. Infectious Animal Solids and Liquids - including carcasses, body parts, body fluids, bedding materials and associated biologicals.

4. Infectious biological solid and liquid wastes from human metabolic functions, including faeces, urine, vomitus, dialysis by-products and the like.

5. Infectious non anatomical waste directly associated with patient care - such as bandages, gowns, masks, gloves, tubing and like equipment.

6. Sharps, including hyperdermic needles, syringes, scalpel blades, broken glass and pasteur pipettes.

7. Infectious Microbiologicals, including serums, vaccines, cultures and stock used in clinical, research and industrial applications and their associated fomites.

8. Chemicals and Pharmaceuticals including antineoplastics and associated fomites.

9. Radioactive [controlled by the Atomic Energy Control Board and the B.C. Ministry of Health].

SECTION 3:

QUESTIONNAIRE:

=====================================================================

DOES YOUR ORGANISATION ATTEMPT TO CLASSIFY
ITS BIOMEDICAL WASTES AS BEING
INFECTIOUS OR NOT INFECTIOUS? YES NO

OR

DOES YOUR ORGANISATION CONSIDER ALL BIOMEDICAL
WASTE PRODUCTS TO BE POTENTIALLY INFECTIOUS AND
HANDLE THEM IN A CONSISTENT MANNER? YES NO

DOES YOUR ORGANISATION CLASSIFY ITS BIOMEDICAL
WASTES INTO THE DEFINED CATEGORIES [1-9]
AS PER THE PRELIMINARY INFORMATION SHEET? YES NO

IF NO, WHAT GROUPINGS ARE USED? ....................................
....................................
....................................
....................................
....................................
....................................
....................................
....................................
....................................

IS THE BIOMEDICAL WASTE SEGREGATED
FOR TREATMENT AND DISPOSAL? YES NO

WHAT METHOD OF SEGREGATION DOES ....................................
YOUR ORGANISATION USE? ....................................
....................................

IS COLOUR CODING USED? YES NO

DESCRIBE THE CHARACTERISTICS OF THE CONTAINERS AND COLOUR CODING USED FOR THE SEGREGATED BIOMEDICAL WASTES.

| | TYPE OF CONTAINER | TYPE OF WASTE | COLOUR CODE |
|---|---|---|---|
| [A] | ...................... | ........................ | ............ |
| [B] | ...................... | ........................ | ............ |
| [C] | ...................... | ........................ | ............ |
| [D] | ...................... | ........................ | ............ |
| [E] | ...................... | ........................ | ............ |
| [F] | ...................... | ........................ | ............ |
| [G] | ...................... | ........................ | ............ |

IS ANY OF THE BIOMEDICAL WASTE PRETREATED PRIOR TO DISPOSAL [e.g. Autoclaving, etc.]? YES NO

WHAT METHODS OF PRETREATMENT OF BIOMEDICAL WASTE ARE USED IN YOUR ORGANISATION?

| | TYPE OF WASTE | PRETREATMENT METHOD |
|---|---|---|
| [A] | ...................... | ........................................ |
| [B] | ...................... | ........................................ |
| [C] | ...................... | ........................................ |
| [D] | ...................... | ........................................ |
| [E] | ...................... | ........................................ |
| [F] | ...................... | ........................................ |
| [G] | ...................... | ........................................ |

WHAT METHODS OF DISPOSAL ARE USED BY YOUR ORGANISATION? [e.g. Incineration, Landfill, Sewerage System, Contracted Out, etc.]

| | TYPE OF WASTE | METHOD OF WASTE DISPOSAL | |
|---|---|---|---|
| | | ON SITE | OFF SITE |
| [A] | ...................... | ................. | ................... |
| [B] | ...................... | ................. | ................... |
| [C] | ...................... | ................. | ................... |
| [D] | ...................... | ................. | ................... |
| [E] | ...................... | ................. | ................... |
| [F] | ...................... | ................. | ................... |
| [G] | ...................... | ................. | ................... |

IF CONTRACTED OUT, PLEASE PROVIDE NAME & ADDRESS OF CONTRACTOR.

NAME: ....................................................
ADDRESS: ....................................................
....................................................
TELEPHONE: ..............

PLEASE PROVIDE ESTIMATE OF WEIGHT [OR VOLUME] OF BIOMEDICAL WASTES PRODUCED WEEKLY BY YOUR ORGANISATION.

| | TYPE OF WASTE | ESTIMATED WEEKLY WEIGHT [VOLUME] | | |
|---|---|---|---|---|
| [A] | ...................... | ..........kg | [or] | ..........$m^3$ |
| [B] | ...................... | ..........kg | [or] | ..........$m^3$ |
| [C] | ...................... | ..........kg | [or] | ..........$m^3$ |
| [D] | ...................... | ..........kg | [or] | ..........$m^3$ |
| [E] | ...................... | ..........kg | [or] | ..........$m^3$ |
| [F] | ...................... | ..........kg | [or] | ..........$m^3$ |
| [G] | ...................... | ..........kg | [or] | ..........$m^3$ |
| TOTAL BIOMEDICAL WASTES: | | ..........kg | [or] | ..........$m^3$ |

SPECIAL BIOMEDICAL WASTES

WHAT ARRANGEMENTS DOES YOUR ORGANISATION
HAVE FOR DISPOSING OF:-

| AGENTS | ARRANGEMENTS |
|---|---|
| RADIOACTIVE MATERIAL | ..........................................<br>.......................................... |
| ANTINEOPLASTIC AGENTS | ..........................................<br>.......................................... |
| PHARMACEUTICAL DRUGS | ..........................................<br>.......................................... |

---

SECTION 4:

COMMENTS:

PLEASE PROVIDE ANY ADDITIONAL COMMENTS THAT YOU FEEL ARE NECESSARY TO EXPAND ON THE ABOVE QUESTIONS AND WHICH WOULD BE OF ASSISTANCE TO THE TASK FORCE IN UNDERSTANDING ANY SPECIAL FACTORS THAT APPLY TO YOUR ORGANISATION.

## SECTION 5:

### INCINERATORS: - ON SITE
[if applicable].

| | | INCINERATOR-<br>PATHOLOGICAL | INCINERATOR-<br>NON-PATHOLOGICAL |
|---|---|---|---|
| Manufacturer: | | .................. | .................. |
| Year Installed: | | .................. | .................. |
| Capacity [weight/hr]: | | ......kg/ ......lbs | ......kg/ .....lbs |
| Capacity [volume]: | Primary | .................. | .................. |
| | Secondary | .................. | .................. |
| Capacity [Burner]: | Primary | .................. | .................. |
| [BTU's/Hour] | Secondary | .................. | .................. |
| Incinerator Operation Period: | | | |
| Maximum: | | [A].... [B]..... | [A].... [B]..... |
| Average: | | [A].... [B]..... | [A].... [B]..... |
| | | [A] = Hours/day | [B] = Days/week |
| Method of Feeding: | | Ramfeed//Manual | Ramfeed//Manual |
| Auxillary Fuel Use: | | | |
| Oil: | | ......$m^3$ per Hour | .....$m^3$ per Hour |
| Natural Gas: | | ......$m^3$ per Hour | .....$m^3$ per Hour |
| Operation Time on Aux Fuel: | | Av. Hours/day...... | Av. Hours/day..... |
| Free Standing in Grounds: | | YES//NO | YES//NO |
| Inside Main Hosp. Buildings: | | YES//NO | YES//NO |

| | | |
|---|---|---|
| Emmission Controls: | YES//NO | YES//NO |
| * Air Pollution Control [Please Circle] | Cyclone<br>Multiclone<br>Wet Scrubber<br>Dry Scrubber<br>Fabric Filter | Cyclone<br>Multiclone<br>Wet Scrubber<br>Dry Scrubber<br>Fabric Filter |
| * Air Pollution Control Equipment Residue Disposal | Quantity...$m^3$/Wk | Quantity...$m^3$/Wk |
| * Method of Residue Disposal | .................. | .................. |
| * Wastewater Disposal | ....$m^3$ per hour | .....$m^3$ per hour |
| * Treatment prior to Disposal | YES//NO | YES//NO |
| * Method of Disposal | .................. | .................. |
| Heat Recovery System [Please Circle] | None<br>Economiser<br>Boiler<br>Waste Heat Boiler | None<br>Economiser<br>Boiler<br>Waste Heat Boiler |
| Condition: [good, fair, poor] | ....... | ....... |
| Recent Renovations | .................. | .................. |
| Future Renovations | .................. | .................. |

ANY ADDITIONAL COMMENTS:

.......................................................................

.......................................................................

.......................................................................

.......................................................................

WHAT ACTION IS TAKEN FOR DISPOSAL WHEN INCINERATOR[s] IS DOWN?

..................................................................

..................................................................

..................................................................

ASH DISPOSAL:

QUANTITY: .................. METHOD: ...........................

=====================================================================

OFF SITE BIOMEDICAL WASTE DISPOSAL:

LANDFILL LOCATION: ............................................
OPERATOR/OWNER: ............................................

INCINERATOR LOCATION: ..............................................
OPERATOR/OWNER: ..............................................

| | | | |
|---|---|---|---|
| TRANSPORTATION: | OWN VEHICLES | YES | NO |
| | MUNICIPLE PICKUP | YES | NO |
| | CONTRACTOR | YES | NO |
| | | | |
| PRIOR COMPACTION [ON SITE] | | YES | NO |

=====================================================================

TRAINING:

| | | |
|---|---|---|
| DO STAFF WITHIN YOUR ORGANISATION WHO HANDLE BIOMEDICAL WASTES HAVE SPECIAL TRAINING? | YES | NO |

WHAT TRAINING PROGRAMMES APPLY?

..................................................................

..................................................................

..................................................................

# BIOMEDICAL WASTE QUESTIONNAIRE

## FACILITIES OTHER THAN HOSPITALS

This questionnaire has been developed by the British Columbia Biomedical Waste Task Force to gather information about the biomedical waste designation, treatment, and disposal practices of various medical facilities in B.C. This questionnaire will be distributed to dentists, orthodontists, periodontists, oral surgeons, veterinary and other animal care facilities, pharmaceutical suppliers, blood banks, mortuaries, crematoria and Coroners' offices. Because it is difficult to design questions that address every situation, we ask that you include your comments whenever you feel clarification of your waste handling practices is needed. The name of your facility will not be attached to this questionnaire. However if you wish to be involved further, please provide a contact name and telephone number in section A of the questionnaire.

For the purpose of answering the questions in a consistent manner, the following definitions are provided.

### Infectious Wastes

Infectious wastes are wastes that are contaminated or suspected of being contaminated with the causative agents, or their toxic products, of a communicable disease, and capable of transmitting such disease to susceptible individuals or animals.

### Biomedical Wastes

Biomedical wastes are those discarded materials which due to their nature and generating source, categorized below, require specific treatment prior to disposal.

#### Waste Categories

1. Infectious solid and liquid biological wastes (i.e. from human metabolic functions) including feces, urine, vomitus, dialysis by-products and the like.
2. Solid human anatomical waste including any body part or tissue except extracted teeth, hair, nail clippings and the like but excluding biological wastes.
3. Liquid human anatomical waste such as blood products, secretions and similar body fluids but excluding biological wastes.

4. Infectious solid and liquid animal waste including carcasses, body parts, body fluids, bedding materials and associated biological wastes.

5. Infectious non-anatomical waste directly associated with patient care such as bandages, gowns, masks, gloves, tubing and like equipment.

6. Sharps including hypodermic needles, syringes, scalpel blades, pasteur pipettes and broken glass.

7. Infectious microbiological waste including serums, vaccines, cultures and stock used in clinical, research and industrial applications and their associated fomites.

8. Chemical and pharmaceutical wastes including antineoplastics and associated fomites.

9. Radioactive waste (controlled by the Atomic Energy Control Board and B.C. Ministry of Health).

Please respond to the following questions on the attached form:

## A. GENERAL

1. Type of facility.

2. Contact name and telephone number.

3. Approximate number of patients, clients or animals per day.

4. How much total solid waste do you generate per month including biomedical waste?(kg. or $m^3$)

5. How much biomedical waste do you generate per month? (kg. or $m^3$)

6. Using the biomedical waste categories provided in the definition:

   a) Please list the types and quantities of wastes you generate.(kg. or $m^3$)

   b) How much do you spend per month for disposal on each waste category?

## B. SEGREGATION AND PACKAGING

7. Do you segregate your biomedical wastes? If so, please indicate how and by whom they are segregated.

8. How do you package and label these wastes? Please describe the containers used, including type, thickness, colour, tags, and method of closure.

## C. STORAGE AND TRANSPORT

9. How often are infectious wastes collected for transport to a storage area or treatment area? By whom?

10. How are infectious wastes transported within the facility?

11. What is the maximum storage time on-site for infectious waste prior to collection or treatment?

12. If non-infectious biomedical wastes are transported off-site, please indicate transportation method and name of transport firm.

13. If infectious wastes are transported off-site, please indicate transportation method and name of transport firm.

## D. DISPOSAL

14. Using the biomedical waste categories provided in the definition, please list the types and quantities of wastes from your facility that are:

    a. Landfilled without treatment.
    b. Landfilled after some form of pre-treatment.
    c. Incinerated on-site.
    d. Incinerated off-site.
    e. Disposed of to a sanitary sewer.

15. If you treat infectious wastes prior to disposal, by what method and where?

16. If you incinerate on-site, how much ash is generated and how is it disposed of? Please specify make and model if incinerator. Is the incinerator ram or hand fed?

17. Do you use any other disposal method? Please describe.

18. What contingency plans do you have for biomedical waste disposal?

## E. COMMENTS

Please use this space to comment on any aspect of biomedical waste designation, treatment and disposal not covered by the questionnaire. Include suggestions for the Task Force regarding the existing biomedical waste situation.

# APPENDIX 4.2

# GENERAL HOSPITAL FACILITY INFORMATION

## APPENDIX 4.2

## TABLE A4.1

## GENERAL INFORMATION ON VICTORIA HOSPITAL FACILITIES

| COUNT | No | Location | Type of facility | Beds | BMW kg/bed/day | Waste Group Used |
|---|---|---|---|---|---|---|
| 1 | 46 | VICTORIA | EXT CARE | 160 | 0.00 | CAT 1-9 |
| 1 | 47 | VICTORIA | HANDICAPPED | 354 | 0.00 | OTHER |
| 1 | 45 | VICTORIA | EXT CARE & REHAB | 388 | 0.00 | CAT 1-9 |
| 1 | 44 | VICTORIA | ACUTE & EXT CARE | 515 | 0.14 | CAT 1-9 |
| 1 | 43 | VICTORIA | ACUTE & EXT CARE | 770 | 2.91 | CAT 1-9 |
| 5 |  |  |  | 2187 |  |  |

# APPENDIX 4.2

## TABLE A4.2

## GENERAL INFORMATION ON GREATER VANCOUVER HOSPITAL FACILITIES

| COUNT | No | Location | Type of facility | Beds | BMW/kg/bed day | Waste Group Used |
|---|---|---|---|---|---|---|
| 1 | 59 | GREATER VANC | TREATMENT CENT | 70 | 0.00 | CAT 1-9 |
| 1 | 60 | GREATER VANC | EXT CARE | 75 | 0.00 | CAT 1-9 |
| 1 | 62 | GREATER VANC | TERT & OBSTET | 120 | 0.19 | OTHER |
| 1 | 51 | GREATER VANC | ACUTE & EXT CARE | 175 | 0.42 | CAT 1-9 |
| 1 | 52 | GREATER VANC | GEN | 187 | 0.17 | CAT 1-9 |
| 1 | 57 | GREATER VANC | GEN | 230 | 0.00 | OTHER |
| 1 | 56 | GREATER VANC | EXT CARE | 240 | 2.71 | OTHER |
| 1 | 61 | GREATER VANC | ACUTE & EXT CARE | 242 | 0.02 | OTHER |
| 1 | 50 | GREATER VANC | EXT CARE | 300 | 0.00 | OTHER |
| 1 | 49 | GREATER VANC | GEN | 323 | 0.79 | CAT 1-9 |
| 1 | 54 | GREATER VANC | ACUTE & EXT CARE | 330 | 0.33 | OTHER |
| 1 | 58 | GREATER VANC | ACUTE | 530 | 4.45 | CAT 1-9 |
| 1 | 48 | GREATER VANC | GEN | 600 | 0.09 | OTHER |
| 1 | 53 | GREATER VANC | GEN | 601 | 3.48 | CAT 1-9 |
| 1 | 55 | GREATER VANC | GEN | 720 | 1.04 | OTHER |
| 1 | 63 | GREATER VANC | GEN | 975 | 0.19 | CAT 1-9 |
| 16 | | | | 5718 | | |

## APPENDIX 4.2

## TABLE A4.3

## GENERAL INFORMATION ON MAJOR URBAN HOSPITAL FACILITIES

| COUNT | No | Location | Type of facility | Beds | BMW/kg/bed day | Waste Group Used |
|---|---|---|---|---|---|---|
| 1 | 2 | MAJOR URBAN | ACUTE & EXT CARE | 265 | 0.73 | CAT 1-9 |
| 1 | 29 | MAJOR URBAN | GEN | 280 | 0.36 | OTHER |
| 1 | 30 | MAJOR URBAN | ACUTE & EXT CARE | 350 | 0.15 | CAT 1-9 |
| 1 | 16 | MAJOR URBAN | GEN | 375 | 0.00 | OTHER |
| 1 | 20 | MAJOR URBAN | GEN | 412 | 1.08 | CAT 1-9 |
| 1 | 31 | MAJOR URBAN | ACUTE & EXT CARE | 433 | 0.00 | OTHER |
| 1 | 26 | MAJOR URBAN | ACUTE & EXT CARE | 600 | 0.00 | OTHER |
| 7 | | | | 2715 | | |

# APPENDIX 4.2

## TABLE A4.4

## GENERAL INFORMATION ON SMALL COMMUNITY HOSPITAL FACILITIES

| COUNT | No | Location | Type of facility | Beds | BMW/kg/bed day | Waste Group Used |
|---|---|---|---|---|---|---|
| 1 | 9 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | CAT 1-9 |
| 1 | 10 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | CAT 1-9 |
| 1 | 13 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | CAT 1-9 |
| 1 | 23 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | OTHER |
| 1 | 25 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | CAT 1-9 |
| 1 | 8 | SMALL COMM | OUTPATIENT CLINIC | 3 | 0.00 | CAT 1-9 |
| 1 | 3 | SMALL COMM | OUTPATIENT CLINIC | 5 | 0.00 | OTHER |
| 1 | 39 | SMALL COMM | CDN FORCES | 6 | 0.71 | OTHER |
| 1 | 4 | SMALL COMM | OUTPATIENT CLINIC | 7 | 0.20 | OTHER |
| 1 | 32 | SMALL COMM | GEN | 7 | 0.20 | CAT 1-9 |
| 1 | 5 | SMALL COMM | GEN | 12 | 0.05 | CAT 1-9 |
| 1 | 19 | SMALL COMM | CDN FORCES | 12 | 0.20 | OTHER |
| 1 | 21 | SMALL COMM | GEN | 18 | 0.08 | CAT 1-9 |
| 1 | 33 | SMALL COMM | GEN | 21 | 0.91 | OTHER |
| 1 | 40 | SMALL COMM | GEN | 25 | 0.06 | OTHER |
| 1 | 17 | SMALL COMM | GEN | 30 | 0.03 | OTHER |
| 1 | 28 | SMALL COMM | ACUTE & EXT CARE | 32 | 0.09 | OTHER |
| 1 | 24 | SMALL COMM | GEN | 37 | 3.24 | OTHER |
| 1 | 14 | SMALL COMM | GEN | 38 | 0.00 | OTHER |
| 1 | 34 | SMALL COMM | GEN | 39 | 1.10 | CAT 1-9 |
| 1 | 37 | SMALL COMM | GEN | 42 | 0.39 | CAT 1-9 |
| 1 | 7 | SMALL COMM | GEN | 48 | 0.06 | OTHER |
| 1 | 11 | SMALL COMM | GEN | 55 | 0.16 | CAT 1-9 |
| 1 | 6 | SMALL COMM | GEN | 57 | 0.13 | CAT 1-9 |
| 1 | 22 | SMALL COMM | GEN | 68 | 0.03 | OTHER |
| 1 | 1 | SMALL COMM | GEN | 71 | 0.03 | CAT 1-9 |
| 1 | 18 | SMALL COMM | GEN | 89 | 0.00 | OTHER |
| 1 | 15 | SMALL COMM | GEN | 93 | 0.74 | OTHER |
| 1 | 12 | SMALL COMM | GEN | 124 | 0.02 | OTHER |
| 1 | 27 | SMALL COMM | ACUTE & EXT CARE | 130 | 0.00 | CAT 1-9 |
| 1 | 38 | SMALL COMM | ACUTE & EXT CARE | 150 | 0.00 | OTHER |
| 1 | 35 | SMALL COMM | GEN | 220 | 0.12 | CAT 1-9 |
| 1 | 41 | SMALL COMM | ACUTE & EXT CARE | 225 | 0.00 | OTHER |
| 1 | 36 | SMALL COMM | ACUTE & EXT CARE | 235 | 2.55 | OTHER |
| 1 | 42 | SMALL COMM | ACUTE & EXT CARE | 468 | 1.83 | CAT 1-9 |
| 35 | | | | 2367 | | |

# APPENDIX 4.3

# DISPOSAL METHODS USED FOR VARIOUS WASTE CATEGORIES

# APPENDIX 4.3

## TABLE A4.5

## DISPOSAL OF VARIOUS TYPES OF BIOMEDICAL WASTE FROM VICTORIA HOSPITALS

| COUNT | No | Location | Type of facility | Beds | Pretreatment | Chm & Phm Disp | Sharps Disp | Microbio Disp | Solid Anatom Disp | Infectious Disp | Radioactive Disp | Antineoplast Disp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 46 | VICTORIA | EXT CARE | 160 | AUTOCL OR BLEA | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | STORAGE & INCIN | OFF SITE INCIN |
| 1 | 47 | VICTORIA | HANDICAPPED | 354 | NONE | SEWER OR RETURN | OFF SITE INCIN | LANDFILL | N/A | OFF SITE INCIN | STORAGE & INCIN | N/A |
| 1 | 45 | VICTORIA | EXT CARE & REHAB | 388 | AUTOCL OR BLEA | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | STORAGE & INCIN | OFF SITE INCIN |
| 1 | 44 | VICTORIA | ACUTE & EXT CARE | 515 | AUTOCL OR BLEA | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | STORAGE & INCIN | OFF SITE INCIN |
| 1 | 43 | VICTORIA | ACUTE & EXT CARE | 770 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | STORAGE & INCIN | ON SITE INCIN |
| 5 |  |  |  | 2187 |  |  |  |  |  |  |  |  |

## APPENDIX 4.3

## TABLE A4.6

## DISPOSAL OF VARIOUS TYPES OF BIOMEDICAL WASTE FROM GREATER VANCOUVER HOSPITALS

| COUNT | No | Location | Type of facility | Beds | Pretreatment | Chm & Phm Disp | Sharps Disp | Microbio Disp | Solid Anatom Disp | Infectious Disp | Radioactive Disp | Antineoplast Disp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 59 | GREATER VANC | TREATMENT CENT | 70 | AUTOCLAVING | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | STORAGE | OFF SITE INCIN |
| 1 | 60 | GREATER VANC | EXT CARE | 75 | NONE | RETURN | - | - | - | - | N/A | N/A |
| 1 | 62 | GREATER VANC | TERT & OBSTET | 120 | NONE | OFF SITE INCIN | OFF SITE INCIN | - | - | OFF SITE INCIN | - | - |
| 1 | 51 | GREATER VANC | ACUTE & EXT CARE | 175 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | NONE | ON SITE INCIN |
| 1 | 52 | GREATER VANC | GEN | 187 | AUTOCLAVING | SEWER | ON SITE INCIN | LANDFILL | LANDFILL | ON SITE INCIN | N/A | SEWER/INCIN |
| 1 | 57 | GREATER VANC | GEN | 230 | NONE | SEWER OR INCIN | LANDFILL | - | - | - | N/A | N/A |
| 1 | 56 | GREATER VANC | EXT CARE | 240 | NONE | SEWER OR INCIN | OFF SITE INCIN | - | - | - | N/A | N/A |
| 1 | 61 | GREATER VANC | ACUTE & EXT CARE | 242 | AUTOCL & FORM | OFF SITE INCIN | OFF SITE INCIN | - | - | OFF SITE INCIN | N/A | - |
| 1 | 50 | GREATER VANC | EXT CARE | 300 | NONE | N/A | OFF SITE INCIN | - | - | - | N/A | N/A |
| 1 | 49 | GREATER VANC | GEN | 323 | AUTOCLAVING | INCIN OR RETURN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | PER AEC | ON SITE INCIN |
| 1 | 54 | GREATER VANC | ACUTE & EXT CARE | 330 | NONE | INCN OR RETURN | ON SITE INCIN | ON SITE INCIN | - | - | - | - |
| 1 | 58 | GREATER VANC | ACUTE | 530 | AUTOCLAVING | ON SITE INCIN | OFF SITE INCIN | ON SITE INCIN | - | ON SITE INCIN | STORAGE & SEWER | OFF SITE INCIN |
| 1 | 48 | GREATER VANC | GEN | 600 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 53 | GREATER VANC | GEN | 601 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | LANDFILL | ON SITE INCIN | - | PER AEC | ON SITE INCIN |
| 1 | 55 | GREATER VANC | GEN | 720 | AUTOCLAVING | ON SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | - | - | OFF SITE | OFF SITE |
| 1 | 63 | GREATER VANC | GEN | 875 | AUTOCALVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | OFF SITE | - |
| 16 | | | | 5718 | | | | | | | | |

APPENDIX 4.3

TABLE A4.7

DISPOSAL OF VARIOUS TYPES OF BIOMEDICAL WASTE FROM MAJOR URBAN HOSPITALS

| COUNT | No | Location | Type of facility | Beds | Pretreatment | Chm & Phm Disp | Sharps Disp | Microbio Disp | Solid Anatom Disp | Infectious Disp | Radioactive Disp | Antineoplast Disp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | MAJOR URBAN | ACUTE & EXT CARE | 265 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 29 | MAJOR URBAN | GEN | 280 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 30 | MAJOR URBAN | ACUTE & EXT CARE | 350 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | LANDFILL | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 16 | MAJOR URBAN | GEN | 375 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | OFF SITE | ON SITE INCIN |
| 1 | 20 | MAJOR URBAN | GEN | 412 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | OFF SITE INCIN | ONSITE INCIN | PER AECB | ON SITE INCIN |
| 1 | 31 | MAJOR URBAN | ACUTE & EXT CARE | 433 | AUTOCLAVING | - | LANDFILL | LANDFILL | OFF SITE INCIN | ON SITE INCIN | - | - |
| 1 | 26 | MAJOR URBAN | ACUTE & EXT CARE | 600 | OTHER | ON SITE INCIN | LANDFILL | ON SITE INCIN | OFF SITE INCIN | ON SITE INCIN | STORAGE | INCIN PER UBC |
| 7 |  |  |  | 2715 |  |  |  |  |  |  |  |  |

# APPENDIX 4.3

## TABLE A4.8

## DISPOSAL OF VARIOUS TYPES OF BIOMEDICAL WASTE FROM SMALL COMMUNITY HOSPITALS

| COUNT | No | Location | Type of facility | Beds | Pretreatment | Chm & Phm Disp | Sharps Disp | Microbio Disp | Solid Anatom Disp | Infectious Disp | Radioactive Disp | Antineoplast Disp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | SMALL COMM | OUTPATIENT CLINIC | 0 | NONE | INCIN OR RETURN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | N/A | OFF SITE INCIN |
| 1 | 10 | SMALL COMM | OUTPATIENT CLINIC | 0 | OTHER | SEWER | OFF SITE INCIN | OFF SITE INCIN | N/A | OFF SITE INCIN | N/A | N/A |
| 1 | 13 | SMALL COMM | OUTPATIENT CLINIC | 0 | NONE | N/A | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | N/A |
| 1 | 23 | SMALL COMM | OUTPATIENT CLINIC | 0 | BLEACHING | SEWER | LANDFILL | LANDFILL | OFF SITE | LANDFILL | N/A | N/A |
| 1 | 25 | SMALL COMM | OUTPATIENT CLINIC | 0 | NONE | OFF SITE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | OFF SITE |
| 1 | 8 | SMALL COMM | OUTPATIENT CLINIC | 3 | NONE | N/A | OFF SITE INCIN | OFF SITE INCIN | N/A | OFF SITE INCIN | N/A | N/A |
| 1 | 3 | SMALL COMM | OUTPATIENT CLINIC | 5 | NONE | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | N/A | OFF SITE INCIN | N/A | OFF SITE INCIN |
| 1 | 39 | SMALL COMM | CDN FORCES | 6 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | N/A |
| 1 | 4 | SMALL COMM | OUTPATIENT CLINIC | 7 | BLEACHING | OFF SITE INCIN | OFF SITE INCIN | LANDFILL | LANDFILL | LANDFILL | N/A | N/A |
| 1 | 32 | SMALL COMM | GEN | 7 | NONE | RETURNED | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | N/A | OFF SITE INCIN |
| 1 | 5 | SMALL COMM | GEN | 12 | AUTOCLAVING | SEWER OR RETURN | LANDFILL | LANDFILL | LANDFILL | LANDFILL | N/A | N/A |
| 1 | 19 | SMALL COMM | CDN FORCES | 12 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 21 | SMALL COMM | GEN | 18 | BLEACHING | SEWER OR INCIN | ON SITE INCIN | ON SITE INCIN | OFF SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 33 | SMALL COMM | GEN | 21 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | N/A |
| 1 | 40 | SMALL COMM | GEN | 25 | NONE | SEWER OR INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 17 | SMALL COMM | GEN | 30 | NONE | INCIN OR RETURN | ON SITE INCIN | ON SITE INCIN | OFF SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 28 | SMALL COMM | ACUTE & EXT CARE | 32 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 24 | SMALL COMM | GEN | 37 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 14 | SMALL COMM | GEN | 38 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 34 | SMALL COMM | GEN | 39 | NONE | SEWER OR INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 37 | SMALL COMM | GEN | 42 | BLEACHING | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | OFF SITE INCIN | N/A | OFF SITE INCIN |
| 1 | 7 | SMALL COMM | GEN | 48 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | INCINERATION | ON SITE INCIN |
| 1 | 11 | SMALL COMM | GEN | 55 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 6 | SMALL COMM | GEN | 57 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 22 | SMALL COMM | GEN | 68 | AUTOCLAVING | SEWER | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 1 | SMALL COMM | GEN | 71 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN OR LF |
| 1 | 18 | SMALL COMM | GEN | 89 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN |
| 1 | 15 | SMALL COMM | GEN | 93 | AUTOCLAVING | INCIN OR RETURN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | INCINERATION | ON SITE INCIN |
| 1 | 12 | SMALL COMM | GEN | 124 | AUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 27 | SMALL COMM | ACUTE & EXT CARE | 130 | NONE | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | OFF SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN |
| 1 | 38 | SMALL COMM | ACUTE & EXT CARE | 150 | NONE | INCIN OR RETURN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | ON SITE INCIN |
| 1 | 35 | SMALL COMM | GEN | 220 | AUTOCLAVING | OFF SITE INCIN | LANDFILL | LANDFILL | OFF SITE INCIN | LANDFILL | N/A | OFF SITE INCIN |
| 1 | 41 | SMALL COMM | ACUTE & EXT CARE | 225 | OUTOCLAVING | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | N/A |
| 1 | 36 | SMALL COMM | ACUTE & EXT CARE | 235 | AUTOCLAVING | OFF SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | ON SITE INCIN | N/A | OFF SITE INCIN |
| 1 | 42 | SMALL COMM | ACUTE & EXT CARE | 468 | BLEACHING | OFF SITE INCIN | ON SITE INCIN | OFF SITE INCIN | ON SITE INCIN | ON SITE INCIN | INCINERATION | OFF SITE INCIN |
| 35 | | | | 2367 | | | | | | | | |

# APPENDIX 4.4

# SEGREGATION AND PACKAGING OF BIOMEDICAL WASTES

# APPENDIX 4.4

## TABLE A4.9

## SEGREGATION AND PACKAGING METHODS USED BY VICTORIA HOSPITALS

| COUNT | No | Location | Type of facility | Beds | Staff Training | Segregation | Sharps Pckg | Infectious Pckg | Chm & Phm Pckg | Antineo Pckg | Anatomical Pckg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 46 | VICTORIA | EXT CARE | 160 | YES | COLOUR & CONT | OPAQUE RC | BLACK RB | ORANGE SB | ORANGE SB | ORANGE SB |
| 1 | 47 | VICTORIA | HANDICAPPED | 354 | NO | COLOUR & CONT | RED RC | GREEN RB | - | N/A | N/A |
| 1 | 45 | VICTORIA | EXT CARE & REHAB | 388 | YES | COLOUR & CONT | OPAQUE RC | BLACK RB | ORANGE SB | ORANGE SB | ORANGE SB |
| 1 | 44 | VICTORIA | ACUTE & EXT CARE | 515 | YES | COLOUR & CONT | OPAQUE RC | BLACK RB | ORANGE SB | ORANGE SB | ORANGE SB |
| 1 | 43 | VICTORIA | ACUTE & EXT CARE | 770 | YES | COLOUR & CONT | OPAQUE RC | BLACK RB | ORANGE SB | ORANGE SB | ORANGE SB |
| 5 |  |  |  | 2187 |  |  |  |  |  |  |  |

NC - NO COLOUR RC - RIGID CONTAINER DB - DOUBLE BAG RB - REGULAR BAG SB - SPECIAL BAG

# APPENDIX 4.4

## TABLE A4.10

## SEGREGATION AND PACKAGING METHODS USED BY GREATER VANCOUVER HOSPITALS

| COUNT | No | Location | Type of facility | Beds | Staff Training | Segregation | Sharps Pckg | Infectious Pckg | Chm & Phm Pckg | Antineo Pckg | Anatomical Pckg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 59 | GREATER VANC | TREATMENT CENT | 70 | - | COLOUR | RED RB | RED RB | - | - | - |
| 1 | 60 | GREATER VANC | EXT CARE | 75 | NO | COLOUR & CONT | ORANGE RC | - | - | - | - |
| 1 | 62 | GREATER VANC | TERT & OBSTET | 120 | - | COLOUR & CONT | NC RC | GREEN RB | - | - | - |
| 1 | 51 | GREATER VANC | ACUTE & EXT CARE | 175 | YES | COLOUR | - | - | RED RB | RED RB | RED RB |
| 1 | 52 | GREATER VANC | GEN | 187 | YES | COLOUR & CONT | RED RC | BLACK RB | - | - | - |
| 1 | 57 | GREATER VANC | GEN | 230 | - | CONTAINERS | NC RC | NC DB | NC DB | - | - |
| 1 | 56 | GREATER VANC | EXT CARE | 240 | YES | COLOUR & CONT | RED RC | RED DB | - | - | - |
| 1 | 61 | GREATER VANC | ACUTE & EXT CARE | 242 | NO | COLOUR & CONT | RED RC | CLEAR RB | - | - | WHITE DB |
| 1 | 50 | GREATER VANC | EXT CARE | 300 | - | CONTAINERS | RED RC | RED DB | - | - | - |
| 1 | 49 | GREATER VANC | GEN | 323 | YES | COLOUR & CONT | - | - | RED RB | RED RB | GREEN DB |
| 1 | 54 | GREATER VANC | ACUTE & EXT CARE | 330 | YES | COLOUR & CONT | RED RC | RED RB | - | - | - |
| 1 | 58 | GREATER VANC | ACUTE | 530 | YES | COLOUR & CONT | WHITE RC | RED RB | - | - | - |
| 1 | 48 | GREATER VANC | GEN | 600 | YES | COLOUR & CONT | YELLOW RC | GREEN RB | ORANGE RC | YELLOW RB | - |
| 1 | 53 | GREATER VANC | GEN | 601 | NO | COLOUR & CONT | WHITE RC | YELLOW RB | YELLOW RB | YELLOW RB | - |
| 1 | 55 | GREATER VANC | GEN | 720 | NO | COLOUR & CONT | - | RED RC | YELLOW RC | - | - |
| 1 | 63 | GREATER VANC | GEN | 975 | YES | COLOUR & CONT | RED RC | WHITE DB | - | - | - |
| 16 | | | | 5718 | | | | | | | |

NC - NO COLOUR RC - RIGID CONTAINER DB - DOUBLE BAG RB - REGULAR BAG SB - SPECIAL BAG

## APPENDIX 4.4

## TABLE A4.11

## SEGREGATION AND PACKAGING METHODS USED BY MAJOR URBAN HOSPITALS

| COUNT | No | Location | Type of facility | Beds | Staff Training | Segregation | Sharps Pckg | Infectious Pckg | Chm & Phm Pckg | Antineo Pckg | Anatomical Pckg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | MAJOR URBAN | ACUTE & EXT CARE | 265 | YES | COLOUR & CONT | YELLOW RC | YELLOW HB | NOTHING SPECIAL | NOTHING SPECIA | NOTHING SPECIAL |
| 1 | 29 | MAJOR URBAN | GEN | 280 | YES | COLOUR & CONT | RED RC | BLACK RB | - | - | - |
| 1 | 30 | MAJOR URBAN | ACUTE & EXT CARE | 350 | YES | COLOUR & CONT | WHITE RC | LABELLED RB | - | RED RB | - |
| 1 | 16 | MAJOR URBAN | GEN | 375 | YES | CONTAINERS | - | - | - | - | - |
| 1 | 20 | MAJOR URBAN | GEN | 412 | YES | COLOUR & CONT | LABELLED RC | YELLOW RB | - | YELLOW RC | LABELLED BOX |
| 1 | 31 | MAJOR URBAN | ACUTE & EXT CARE | 433 | YES | COLOUR & CONT | RED/YELLOW R | CLEAR RB | - | - | NC DB |
| 1 | 26 | MAJOR URBAN | ACUTE & EXT CARE | 600 | NO | CONTAINERS | WHITE/YELLOW | ORANGE/YELLOW B | ORANGE/YELLOW BO | - | - |
| 7 |  |  |  | 2715 |  |  |  |  |  |  |  |

NC - NO COLOUR RC - RIGID CONTAINER DB - DOUBLE BAG RB - REGULAR BAG SB - SPECIAL BAG

# APPENDIX 4.4

## TABLE A4.12

## SEGREGATION AND PACKAGING METHODS USED BY COMMUNITY HOSPITALS

| COUNT | No | Location | Type of facility | Beds | Staff Training | Segregation | Sharps Pckg | Infectious Pckg | Chm & Phm Pckg | Antineo Pckg | Anatomical Pckg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | SMALL COMM | OUTPATIENT CLINIC | 0 | NO | NONE | NC | NC | NC | N/A | N/A |
| 1 | 10 | SMALL COMM | OUTPATIENT CLINIC | 0 | NO | COLOUR & CONT | RED RC | RED RC | N/A | N/A | WHITE RC |
| 1 | 13 | SMALL COMM | OUTPATIENT CLINIC | 0 | NO | CONTAINERS | RED RC | - | - | - | - |
| 1 | 23 | SMALL COMM | OUTPATIENT CLINIC | 0 | YES | COLOUR & CONT | LABELLED RC | GREEN RB | - | - | - |
| 1 | 25 | SMALL COMM | OUTPATIENT CLINIC | 0 | NO | COLOUR & CONT | RED RC | - | NC BOX | - | - |
| 1 | 8 | SMALL COMM | OUTPATIENT CLINIC | 3 | NO | NONE | NC | NC | NC | N/A | N/A |
| 1 | 3 | SMALL COMM | OUTPATIENT CLINIC | 5 | YES | LABELS & CONT | LABELLED RC | LABELLED DB | LABELLED RC | NOTHING SPECIA | LABELLED DB |
| 1 | 39 | SMALL COMM | CDN FORCES | 6 | NO | NONE | N/A | N/A | N/A | N/A | N/A |
| 1 | 4 | SMALL COMM | OUTPATIENT CLINIC | 7 | YES | COLOUR & CONT | NC RC | YELLOW DB | NC DB | NC DB | NC DB |
| 1 | 32 | SMALL COMM | GEN | 7 | YES | COLOUR & CONT | NC RC | RED RB | - | RED RB | RED RB |
| 1 | 5 | SMALL COMM | GEN | 12 | NO | NONE | NC RB | NC RB | NC RB | NC RB | NC RB |
| 1 | 19 | SMALL COMM | CDN FORCES | 12 | NO | COLOUR & CONT | RED RC | - | - | - | ORANGE RB |
| 1 | 21 | SMALL COMM | GEN | 18 | NO | CONTAINERS | RED RC | - | - | - | - |
| 1 | 33 | SMALL COMM | GEN | 21 | NO | CONTAINERS | RED RC | - | - | - | - |
| 1 | 40 | SMALL COMM | GEN | 25 | YES | COLOUR & CONT | RED RC | RED RB | - | - | - |
| 1 | 17 | SMALL COMM | GEN | 30 | YES | COLOUR & CONT | RED RC | RED RB | - | RED RC | - |
| 1 | 28 | SMALL COMM | ACUTE & EXT CARE | 32 | NO | LABELS & CONT | NC BOX | ORANGE/YELLOW B | - | - | - |
| 1 | 24 | SMALL COMM | GEN | 37 | - | COLOUR & CONT | RED RC | CLEAR SB | - | - | - |
| 1 | 14 | SMALL COMM | GEN | 38 | NO | CONTAINERS | RED RC | - | - | - | - |
| 1 | 34 | SMALL COMM | GEN | 39 | YES | CONTAINERS | NC RC | NC RB | - | - | - |
| 1 | 37 | SMALL COMM | GEN | 42 | NO | COLOUR & CONT | WHITE RC | RED RB | - | - | - |
| 1 | 7 | SMALL COMM | GEN | 48 | NO | COLOUR | LABELLED RC | LABELLED DB | NOTHING SPECIAL | NOTHING SPECIA | LABELLED DB |
| 1 | 11 | SMALL COMM | GEN | 55 | YES | LABELS & CONT | - | RED RB | WHITE | - | - |
| 1 | 6 | SMALL COMM | GEN | 57 | YES | COLOUR & CONT | RED RC | LABELLED RB | LABELLED RB | LABELLED RB | LABELLED RB |
| 1 | 22 | SMALL COMM | GEN | 68 | NO | NONE | N/A | N/A | N/A | N/A | N/A |
| 1 | 1 | SMALL COMM | GEN | 71 | NO | COLOUR | NOTHING SPEC | NOTHING SPECIAL | NOTHING SPECIAL | WHITE/YELLOW | NOTHING SPECIAL |
| 1 | 18 | SMALL COMM | GEN | 89 | YES | COLOUR & CONT | RED RC | - | - | - | - |
| 1 | 15 | SMALL COMM | GEN | 93 | YES | COLOUR & CONT | NC RC | YELLOW DB | LABELLED RB | - | - |
| 1 | 12 | SMALL COMM | GEN | 124 | YES | COLOUR | - | RED SB | - | WHITE SB | - |
| 1 | 27 | SMALL COMM | ACUTE & EXT CARE | 130 | YES | LABELS & CONT | YELLOW SB | YELLOW SB | - | - | - |
| 1 | 38 | SMALL COMM | ACUTE & EXT CARE | 150 | NO | COLOUR & CONT | WHITE RC | RED SB | RED SB | - | - |
| 1 | 35 | SMALL COMM | GEN | 220 | YES | COLOUR & CONT | YELLOW RC | RED RC | - | - | - |
| 1 | 41 | SMALL COMM | ACUTE & EXT CARE | 225 | YES | COLOUR & CONT | LABELLED RC | ORANGE RB | - | - | - |
| 1 | 36 | SMALL COMM | ACUTE & EXT CARE | 235 | YES | LABELS & CONT | RED RC | RED RB | - | LABELLED RC | - |
| 1 | 42 | SMALL COMM | ACUTE & EXT CARE | 468 | NO | COLOUR & CONT | WHITE/YELLOW | LABELLED DB | - | - | - |
| 35 | | | | 2367 | | | | | | | |

NC - NO COLOUR RC - RIGID CONTAINER DB - DOUBLE BAG RB - REGULAR BAG SB - SPECIAL BAG

# APPENDIX 4.5

# INCINERATOR DATA FOR HOSPITALS

# APPENDIX 4.5

## TABLE A4.13

## INCINERATOR DATA FOR VICTORIA HOSPITALS

| COUNT | No | Location | Type of facility | Beds | BMW kg bed day | Year Inst | Incinerator Typ | Capacity kg per h | Max Hrs Op Wk | Avg Hrs Op Wk | Aux Fuel | Con | Kg of Ash per wk | Renov | Contingency P | Incineration Lo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 46 | VICTORIA | EXT CARE | 180 | 0.00 | | NONE | | | | | | | | | |
| 1 | 47 | VICTORIA | HANDICAPPED | 354 | 0.00 | | NONE | | | | | | | | | |
| 1 | 45 | VICTORIA | EXT CARE & REHAB | 388 | 0.00 | | NONE | | | | | | | | | |
| 1 | 44 | VICTORIA | ACUTE & EXT CARE | 515 | 0.14 | | NONE | | | | | | | | | |
| 1 | 43 | VICTORIA | ACUTE & EXT CARE | 770 | 2.91 | 1977 | PATH | 1300 | 30 | 15 | OIL | - | - | YES | STORED ON SITE | FBIG |
| 5 | | | | 2187 | | | | | | | | | | | | |

# APPENDIX 4.5

## TABLE A4.14

## INCINERATOR DATA FOR GREATER VANCOUVER HOSPITALS

| COUNT | No | Location | Type of facility | Beds | BMW kg bed day | Year Inst | Incinerator Typ | Capacity kg per h | Max Hrs Op Wk | Avg Hrs Op Wk | Aux Fuel | Con | Kg of Ash per wk | Renov | Contingency Pl | Incineration Lo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 59 | GREATER VANC | TREATMENT CENT | 70 | 0.00 | | NONE | | | | | | | | | |
| 1 | 60 | GREATER VANC | EXT CARE | 75 | 0.00 | | NONE | | | | | | | | | |
| 1 | 62 | GREATER VANC | TERT & OBSTET | 120 | 0.19 | | NONE | | | | | | | | | |
| 1 | 51 | GREATER VANC | ACUTE & EXT CARE | 175 | 0.42 | 1981 | PATH | 21 | 42 | 38.5 | GAS | GOOD | | YES | NONE | FBIG |
| 1 | 52 | GREATER VANC | GEN | 187 | 0.17 | 1958 | NON PATH | 28 | 168 | 84 | GAS | POOR | 70 | | STORED ON SITE | IMHB |
| 1 | 57 | GREATER VANC | GEN | 230 | 0.00 | | NONE | | | | | | | | | |
| 1 | 56 | GREATER VANC | EXT CARE | 240 | 2.71 | | NONE | | | | | | | | | |
| 1 | 61 | GREATER VANC | ACUTE & EXT CARE | 242 | 0.02 | | NONE | | | | | | | | | |
| 1 | 50 | GREATER VANC | EXT CARE | 300 | 0.00 | - | NONE | - | - | - | - | - | - | - | - | - |
| 1 | 49 | GREATER VANC | GEN | 323 | 0.79 | 1985 | PATH | 90 | 10.5 | 7 | - | POOR | - | YES | STORED ON SITE | IMBH |
| 1 | 54 | GREATER VANC | ACUTE & EXT CARE | 330 | 0.33 | 1968 | NON PATH | 37 | 56 | 35 | - | GOOD | - | YES | OFF SITE INCIN | IMHB |
| 1 | 58 | GREATER VANC | ACUTE | 530 | 4.45 | 1981 | PATH | 38 | 112 | 84 | GAS | FAIR | | YES | STORED ON SITE | - |
| 1 | 48 | GREATER VANC | GEN | 800 | 0.09 | 1971 | NON PATH | 240 | 48 | 35 | GAS | GOOD | - | YES | STORED ON SITE | IMHB |
| 1 | 53 | GREATER VANC | GEN | 801 | 3.48 | 1978 | PATH | - | 2 | 2 | - | - | - | - | NONE | FBIG |
| 1 | 55 | GREATER VANC | GEN | 720 | 1.04 | 1972 | PATH | - | 91 | 70 | - | - | | YES | OFF SITE INCIN | IMHB |
| 1 | 63 | GREATER VANC | GEN | 875 | 0.19 | 1982 | PATH | 96 | 56 | 56 | GAS | GOOD | | YES | OFF SITE INCIN | FBIG |
| 16 | | | | 5718 | | | | | | | | | | | | |

# APPENDIX 4.5

## TABLE A4.15

## INCINERATOR DATA FOR MAJOR URBAN HOSPITALS

| COUNT | No | Location | Type of facility | Beds | BMW kg bed day | Year Inst | Incinerator Typ | Capacity kg per h | Max Hrs Op Wk | Avg Hrs Op Wk | Aux Fuel | Con | Kg of Ash per wk | Renov | Contingency Pl | Incineration Lo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | MAJOR URBAN | ACUTE & EXT CARE | 265 | 0.73 | 1987 | NON PATH | 70 | - | - | GAS | GOOC | - | - | STORED ON SITE | FBIG |
| 1 | 29 | MAJOR URBAN | GEN | 280 | 0 36 | 1981 | PATH | 25 | 90 | 75 | GAS | - | - | - | STORED ON SITE | IMHB |
| 1 | 30 | MAJOR URBAN | ACUTE & EXT CARE | 350 | 0 15 | 1985 | PATH | 45 | 24 | - | - | GOOC | - | YES | OFF SITE INCIN | FBIG |
| 1 | 16 | MAJOR URBAN | GEN | 375 | 0 00 | 1987 | PATH | 100 | 4 | 3 | GAS | GOOC | - | YES | OFF SITE INCIN | IMHB |
| 1 | 20 | MAJOR URBAN | GEN | 412 | 1.08 | 1984 | NON PATH | 150 | 10 | 10 | - | POOR | - | YES | STORED ON SITE | IMHB |
| 1 | 31 | MAJOR URBAN | ACUTE & EXT CARE | 433 | 0 00 | 1984 . | PATH | 110 | - | - | GAS | - | - | - | NONE | IMHB |
| 1 | 28 | MAJOR URBAN | ACUTE & EXT CARE | 600 | 0 00 | - | NON PATH | 200 | 10 | - | GAS | FAIR | - | NO | NONE | IMHB |
| 7 | | | | 2715 | | | | | | | | | | | | |

# APPENDIX 4.5

## TABLE A4.16

## INCINERATOR DATA FOR SMALL COMMUNITY HOSPITALS

| COUNT | No | Location | Type of facility | Beds | BMW kg bed day | Year Inst | Incinerator /Typ | Capacity kg per h | Max Hrs Op Wk | Avg Hrs Op Wk | Aux Fuel | Con | Kg of Ash per wk | Renew | Contingency P | Incineration Lo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | | NONE | | | | | | | | | |
| 1 | 10 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | | NONE | | | | | | | | | |
| 1 | 13 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | 1977 | PATH | 20 | - | - | GAS | GOOC | - | - | - | FBIG |
| 1 | 23 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | | NONE | | | | | | | | | |
| 1 | 25 | SMALL COMM | OUTPATIENT CLINIC | 0 | 0.00 | - | PATH | - | - | - | - | - | - | - | LANDFILL | - |
| 1 | 8 | SMALL COMM | OUTPATIENT CLINIC | 3 | 0.00 | | NONE | | | | | | | | | |
| 1 | 3 | SMALL COMM | OUTPATIENT CLINIC | 5 | 0.00 | 1980 | PATH | 40 | - | 25 | - | - | - | - | - | IMHB |
| 1 | 30 | SMALL COMM | CDN FORCES | 6 | 0.71 | 1987 | PATH | 100 | 15 | 10 | GAS | EXCEL | 2.5 | YES | NONE | FBIG |
| 1 | 4 | SMALL COMM | OUTPATIENT CLINIC | 7 | 0.20 | | NONE | | | | | | | | | |
| 1 | 32 | SMALL COMM | GEN | 7 | 0.20 | | NONE | | | | | | | | | |
| 1 | 5 | SMALL COMM | GEN | 12 | 0.05 | | NONE | | | | | | | | | |
| 1 | 19 | SMALL COMM | CDN FORCES | 12 | 0.20 | 1988 | PATH | 20 | 58 | 8 | OIL | GOOC | - | NO | STORED ON SITE | FBIG |
| 1 | 21 | SMALL COMM | GEN | 18 | 0.08 | - | NON PATH | - | - | - | GAS | - | - | - | - | FBIG |
| 1 | 33 | SMALL COMM | GEN | 21 | 0.91 | 1985 | PATH | - | 14 | 10.5 | - | GOOC | - | YES | | FBIG |
| 1 | 40 | SMALL COMM | GEN | 25 | 0.08 | 1982 | PATH | 24 | 18 | - | OIL | GOOC | - | YES | NONE | FBIG |
| 1 | 17 | SMALL COMM | GEN | 30 | 0.03 | 1970 | NON PATH | 45 | 21 | 14 | - | - | - | - | NONE | IMHB |
| 1 | 28 | SMALL COMM | ACUTE & EXT CARE | 32 | 0.09 | 1977 | PATH | 45 | 25 | 10 | OIL | GOOC | - | YES | STORED ON SITE | IMHB |
| 1 | 24 | SMALL COMM | GEN | 37 | 3.24 | 1973 | PATH | - | - | - | GAS | - | - | - | OFF SITE INCIN | IMHB |
| 1 | 14 | SMALL COMM | GEN | 38 | 0.00 | 1984 | PATH | - | 5 | 5 | GAS | GOOC | - | - | NONE | IMHB |
| 1 | 34 | SMALL COMM | GEN | 38 | 1.10 | 1987 | PATH | - | 28 | 14 | OIL | - | - | - | | FBIG |
| 1 | 37 | SMALL COMM | GEN | 42 | 0.38 | | NONE | | | | | | | | | |
| 1 | 7 | SMALL COMM | GEN | 48 | 0.08 | 1984 | PATH | 90 | 14 | - | GAS | GOOC | 45 | YES | OFF SITE INCIN | IMHB |
| 1 | 11 | SMALL COMM | GEN | 55 | 0.18 | 1971 | NON PATH | - | 30 | 24 | GAS | POOR | 35 | NO | STORED ON SITE | IMHB |
| 1 | 6 | SMALL COMM | GEN | 57 | 0.13 | 1971 | NON PATH | - | 8 | 3 | OIL | - | 23 | - | OFF SITE INCIN | IMHB |
| 1 | 22 | SMALL COMM | GEN | 88 | 0.03 | 1961 | NON PATH | 70 | 7 | 7 | OIL | - | - | - | NONE | IMHB |
| 1 | 1 | SMALL COMM | GEN | 71 | 0.03 | 1988 | PATH | - | - | - | - | - | - | - | STORED ON SITE | IMHB |
| 1 | 18 | SMALL COMM | GEN | 88 | 0.00 | 1958 | NON PATH | 120 | 91 | 70 | GAS | FAIR | - | YES | OFF SITE INCIN | FBIG |
| 1 | 15 | SMALL COMM | GEN | 93 | 0.74 | 1958 | NON PATH | 70 | 28 | 21 | OIL | - | 128 | - | OFF SITE INCIN | IMHB |
| 1 | 12 | SMALL COMM | GEN | 124 | 0.02 | 1969 | NON PATH | - | 20 | 10 | GAS | GOOD | - | YES | LANDFILL | IMHB |
| 1 | 27 | SMALL COMM | ACUTE & EXT CARE | 130 | 0.00 | 1968 | PATH | 150 | - | - | - | - | - | - | OFF SITE INCIN | IMHB |
| 1 | 38 | SMALL COMM | ACUTE & EXT CARE | 150 | 0.00 | 1970 | PATH | | 0.5 | 1.17 | OIL | POOR | - | NO | OFF SITE INCIN | IMHB |
| 1 | 35 | SMALL COMM | GEN | 220 | 0.12 | 1967 | NON PATH | - | - | - | - | POOR | - | - | | |
| 1 | 41 | SMALL COMM | ACUTE & EXT CARE | 225 | 0.00 | 1982 | PATH | 140 | 84 | 58 | GAS | GOOC | - | NO | STORED ON SITE | FBIG |
| 1 | 36 | SMALL COMM | ACUTE & EXT CARE | 235 | 2.55 | 1948 | NON PATH | | 98 | 70 | OIL | FAIR | - | YES | STORED ON SITE | IMHB |
| 1 | 42 | SMALL COMM | ACUTE & EXT CARE | 468 | 1.83 | 1962 | NON PATH | 240 | - | - | GAS | GOOD | - | YES | OFF SITE INCIN | IMHB |
| 35 | | | | 2367 | | | | | | | | | | | | |

# APPENDIX 5.0

## INVENTORY OF BIOMEDICAL WASTE GENERATED IN B.C. AND ELSEWHERE

PAGE

APPENDIX 5.1 DEFINITION OF TYPE A BIOMEDICAL WASTES 1

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# APPENDIX 5.1

# DEFINITION OF TYPE A BIOMEDICAL WASTES

## Biomedical Waste Type A

Class 1 Human anatomical waste (infectious and non-infectious) includes any part of the human body, tissues, blood or bodily fluids but excludes noninfectious blood and bodily fluids, extracted teeth, nail clippings and hair and the like.

Class 2 Animal anatomical waste includes all or any part of an animal, or tissue or bodily fluid of animal origin, that is infected or contaminated with an agent of a communicable disease or any agent, bacterium, virus, spore, cell, culture, medium or organism which is capable of causing disease or cell damage in humans or animals.

Class 3 Non-anatomical waste including:

a) Waste, from any source whatsoever:

(i) which is, or may be infected or contaminated with an agent of a communicable disease or any agent, bacterium, virus, spore, cell, culture, medium or organism which is capable of causing disease or cell damage in humans or animals, or which is:

(ii) a cytotoxic agent (antineoplastic) or equipment contaminated with a cytotoxic agent (antineoplastic) used in the treatment of cancer.

b) Laboratory wastes including, but not limited to: tissue, pus, blood, bodily fluids, feces, saliva, sputum, urine, exudates, microbiological and tissue cultures, vaccines, specimens and including specimen containers, waste containers, needles, syringes, and other laboratory equipment and materials contaminated with any of the above.

c) Any waste product of, or equipment used in: the production and use of recombinant DNA and hybrid or mutant organisms; animal virus research and synthesis; and animal cell research and production.

(Environment Canada, 1988)

## APPENDIX 5.2

## Estimated Wastes Generated in Hospitals in British Columbia 1987

| Hospital | Esimated Waste Generated (kg/day) | | |
|---|---|---|---|
| | Total* | Biomedical (Type A)* | Infectious Waste* |
| Matsqui-Sumas- Abbotsford General | 1216 | 152 | 121.6 |
| Menno | 300 | 37.5 | 30 |
| Alert Bay- St. Georges | 156 | 19.5 | 15.6 |
| Armstrong and Spallumcheen | 64 | 8 | 6.4 |
| Ashcroft and District General | 140 | 17.5 | 14 |
| Bella Coola General | 60 | 7.5 | 6 |
| Burnaby Hospital | 2404 | 300.5 | 240.4 |
| Burnaby-Fellburn | 300 | 37.5 | 30 |
| Burnaby-St. Michaels | 320 | 40 | 32 |
| Burnaby-Dogwood 2 | 616 | 77 | 61.6 |
| Burn's Lake and District Hospital | 168 | 21 | 16.8 |
| Campbell River and District Hospital | 552 | 69 | 55.2 |
| Cassiar | 24 | 3 | 2.4 |
| Castlegar and District Hospital | 280 | 35 | 28 |
| Chemainus Hospital | 112 | 14 | 11.2 |
| Chetwynd General | 72 | 9 | 7.2 |
| Chilliwack General | 1104 | 138 | 110.4 |
| Clearwater- Dr. Helmcken Memorial | 40 | 5 | 4 |
| Comox-St. Joseph's General | 800 | 100 | 80 |
| Cranbrook and District Hospital | 520 | 65 | 52 |
| Creston Valley Hospital | 256 | 32 | 25.6 |
| Cumberland Care Facility | 300 | 37.5 | 30 |
| Dawson Creek and District Hospital | 308 | 38.5 | 30.8 |
| Delta Hospital | 640 | 80 | 64 |
| Duncan-Cowichan District | 940 | 117.5 | 94 |
| Enderby and District Hospital | 128 | 16 | 12.8 |
| Fernie District Hospital | 260 | 32.5 | 26 |
| Fort Nelson General | 164 | 20.5 | 16.4 |
| Fort St. James-Stuart Lake Hospital | 100 | 12.5 | 10 |
| Fort St. John General | 384 | 48 | 38.4 |
| Ganges-Lady Menno | 200 | 25 | 20 |
| Golden | 132 | 16.5 | 13.2 |
| Grand Forks-Boundary Hospital | 280 | 35 | 28 |
| Hazleton-Wrinch Memorial | 128 | 16 | 12.8 |
| Hope-Fraser Canyon Hospital | 152 | 19 | 15.2 |
| Invermere-Windemere District Hospital | 124 | 15.5 | 12.4 |
| TOTAL: | 13744 | 1718 | 1374.4 |

Hospital bed statistics for 1987 supplied by the Ministry of Health, Province of British Columbia.

*total waste=4 kg/bed/day
biomedical(typeA)=0.5kg/bed/day
infectious waste=10% of total waste

## APPENDIX 5.2 (continued)

## Estimated Wastes Generated in Hospitals in British Columbia 1987

| Hospital | Esimated Waste Generated (kg/day) | | |
|---|---|---|---|
| | Total* | Biomedical (Type A)* | Infectious Waste* |
| Kamloops-Royal Inland | 1536 | 192 | 153.6 |
| Kamloops-Overlander | 600 | 75 | 60 |
| Kamloops-Ponderosa | 1024 | 128 | 102.4 |
| Kaslo-Victorian Hospital | 40 | 5 | 4 |
| Kelowna General | 2352 | 294 | 235.2 |
| Kimberley and District Hospital | 268 | 33.5 | 26.8 |
| Kitimat General | 432 | 54 | 43.2 |
| Ladysmith and District General | 168 | 21 | 16.8 |
| Langley Memorial | 1232 | 154 | 123.2 |
| Lilloet District Hospital | 148 | 18.5 | 14.8 |
| Lytton-St. Bartholemew's | 80 | 10 | 8 |
| McBride and District Hospital | 84 | 10.5 | 8.4 |
| MacKenzie and District Hospital | 72 | 9 | 7.2 |
| Maple Ridge Hospital | 1024 | 128 | 102.4 |
| Masset-Canadian Forces | 48 | 6 | 4.8 |
| Merritt-Nicola Valley General | 180 | 22.5 | 18 |
| Mission Memorial | 636 | 79.5 | 63.6 |
| Nakusp-Arrow Lakes | 80 | 10 | 8 |
| Nanaimo Regional General | 1484 | 185.5 | 148.4 |
| Nelson-Kootenay Lake | 356 | 44.5 | 35.6 |
| Nelson-Mt. St. Francis | 336 | 42 | 33.6 |
| New Denver-Slocan Community | 40 | 5 | 4 |
| New Westminister-Queen's Park | 1200 | 150 | 120 |
| New Westminister- Royal Columbian | 2168 | 271 | 216.8 |
| New Westminister-Saint Mary's | 748 | 93.5 | 74.8 |
| North Vancouver-Lions Gate | 2880 | 360 | 288 |
| Oliver-South Okanagan General | 480 | 60 | 48 |
| 100 Mile House District General | 268 | 33.5 | 26.8 |
| Parksville-Trillium Lodge | 420 | 52.5 | 42 |
| Penticton Hospital | 1040 | 130 | 104 |
| Port Alberni-West Coast General | 600 | 75 | 60 |
| Port Alice Hospital | 28 | 3.5 | 2.8 |
| Port Hardy Hospital | 100 | 12.5 | 10 |
| Port McNeill and District | 40 | 5 | 4 |
| Port Moody-Eagle Ridge | 420 | 52.5 | 42 |
| Pouce Coupe Community Hospital | 216 | 27 | 21.6 |
| Powell River General | 484 | 60.5 | 48.4 |
| Prince George Regional | 1428 | 178.5 | 142.8 |
| Prince Rupert Regional | 496 | 62 | 49.6 |
| Princeton General | 120 | 15 | 12 |
| Queen Chartlotte Islands General | 84 | 10.5 | 8.4 |
| Quesnel-G.R. Baker Memorial | 432 | 54 | 43.2 |
| Revelstoke-Queen Victoria | 224 | 28 | 22.4 |
| Richmond General | 1328 | 166 | 132.8 |
| TOTAL: | 27424 | 3428 | 2742.4 |

Hospital bed statistics for 1987 supplied by the Ministry of Health, Province of British Columbia.

*total waste=4 kg/bed/day
biomedical(typeA)=0.5kg/bed/day
infectious waste=10% of total waste

## APPENDIX 5.2 (continued)

## Estimated Wastes Generated in Hospitals in British Columbia 1987

| Hospital | Esimated Waste Generated (kg/day) | | |
|---|---|---|---|
| | Total* | Biomedical (Type A)* | Infectious Waste* |
| Rossland-Mater Misercordiae | 164 | 20.5 | 16.4 |
| Saanich Penninsula | 900 | 112.5 | 90 |
| Salmon Arm-Shuswap General | 372 | 46.5 | 37.2 |
| San Josef-Canadian Forces Holberg | 28 | 3.5 | 2.8 |
| Sechelt-St. Mary's | 280 | 35 | 28 |
| Smithers-Bulkley Valley District | 220 | 27.5 | 22 |
| Sparwood General | 108 | 13.5 | 10 |
| Squamish General | 236 | 29.5 | 23.6 |
| Stewart General | 40 | 5 | 4 |
| Summerland General | 312 | 39 | 31.2 |
| Surrey Memorial | 2400 | 300 | 240 |
| Tahsis Hospital | 40 | 5 | 4 |
| Terrace Mills Memorial | 356 | 44.5 | 35.6 |
| Tofino General | 84 | 10.5 | 8.4 |
| Trail Regional | 880 | 110 | 88 |
| Vancouver-A.Maxwell Evans Clinic | 336 | 42 | 33.6 |
| Vancouver-Children's Hospital | 740 | 92.5 | 74 |
| Vancouver-G.F.Strong Rehab | 600 | 75 | 60 |
| Vancouver-Salvation Army Grace | 480 | 60 | 48 |
| Vancouver-Holy Family | 920 | 115 | 92 |
| Vancouver-Louis Brier | 240 | 30 | 24 |
| Vancouver-Mt. St. Joseph | 1084 | 135.5 | 108.4 |
| Vancouver-Pearson | 728 | 91 | 72.8 |
| Vancouver-St. Paul's | 2204 | 275.5 | 220.4 |
| Vancouver-St. Vincent's | 928 | 116 | 92.8 |
| Vancouver-St. Vincent's Arbutus | 300 | 37.5 | 30 |
| Vancouver-Shaughnessy | 3900 | 487.5 | 390 |
| Vancouver-Sunny Hill | 280 | 35 | 28 |
| Vancouver-UBC Health Sciences Centre | 2264 | 283 | 226.4 |
| Vancouver General | 4804 | 600.5 | 480.4 |
| Vancouver-Dogwood 1 | 616 | 77 | 61.6 |
| Vanderhoof-St. John | 180 | 22.5 | 18 |
| Vernon Jubilee | 1492 | 186.5 | 149.2 |
| Victoria-Glendale Lodge | 300 | 37.5 | 30 |
| Victoria-Gorge Road | 1552 | 194 | 155.2 |
| Victoria-Jaun de Fuca Hospitals | 1920 | 240 | 192 |
| Victoria-Mt. St. Mary | 504 | 63 | 50.4 |
| Victoria-Queen Alexandra | 372 | 46.5 | 37.2 |
| Victoria-Royal Jubilee | 3092 | 386.5 | 309.2 |
| Victoria General | 2328 | 291 | 232.8 |
| Waglisa-R.W. Large Memorial | 92 | 11.5 | 9.2 |
| White Rock-Peace Arch District Hospital | 904 | 113 | 90.4 |
| Williams Lake-Cariboo Memorial | 436 | 54.5 | 43.6 |
| TOTAL | 40016 | 4869 | 4000.8 |
| GRAND TOTAL | 81184 | 10015 | 8118.4 |

Hospital bed statistics for 1987 supplied by the Ministry of Health, Province of British Columbia.

*total waste=4 kg/bed/day
biomedical(typeA)=0.5kg/bed/day
infectious waste=10% of total waste

# APPENDIX 5.3

## 5.3 REFERENCES

Environment Canada, 1988. State-of-the-Art Report on the Management of Biomedical (Type A) Wastes in Canada. Environmental Protection Service, Conservation and Protection, Environment Canada, Atlantic Region.

# APPENDIX 6.0

## BIOMEDICAL WASTE HANDLING, STORAGE, TRANSPORT, TREATMENT AND DISPOSAL

PAGE

APPENDIX 6.1 HANDLING, STORAGE AND TRANSPORT TECHNOLOGIES 1

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# APPENDIX 6.1

## 6.1 HANDLING, STORAGE AND TRANSPORT TECHNOLOGIES

This section reviews the different biomedical waste management technologies described in the literature. The suitability of each technology for specific types of waste is discussed wherever options are possible. Available information was not sufficient to establish the extent to which each technology is applied or used in Canada.

### Storage

Within the management of biomedical wastes, storage consists of three stages:
1) primary; 2) waste-holding; 3) pre-disposal.

i ) Primary Storage. The first stage is usually at the point of origin and involves the use of small receptacles. The advent of plastics on the market has been a major breakthrough, in terms of primary storage methods. The use of waste baskets, laundry hampers, carts, buckets (Bond et al, 1973) or special holders for hanging autoclavable bags for laboratories (WHO, 1983) has been developed as primary storage containers. The use of the above is completed by lining them with plastic bags for ease of collection, reduction of cleaning frequency and time, and elimination of the risks of cross-contamination (Environment Canada, 1988). A single bag is normally adequate if it is impervious and sturdy (not easily penetrated) and if the article can be placed in the bag without contaminating the outside of the bag. Otherwise, double bagging should be used (CSA, 1988).

The ideal plastic bag as primary storage container is a compromise between resistance to internal or external mechanical damage and ease of thermal destruction. The segregation of wastes can be simplified at the primary storage stage by using colour coded bags. The following requirements have been recommended:

- outer bag may be less than 0.04 mm (1.5 mils) but not less than 0.032 mm (1.25 mils);
- inner bag for pathological waste and institutional waste shall be at least 0.051 mm (2 mils) (Environment Canada, 1988)

(ii) Intermediate and Final Storage Areas. Most biomedical wastes (either infectious or non-infectious) by-pass the waste holding stage and go directly to predisposal on a special collection or on an "as necessary" basis. All other biomedical waste (noninfectious or previously sterilized are stored temporarily in a waste holding area, located usually in a central section of a facility floor or department. The wastes are then routed to a predisposal area usually receiving all the segregated wastes from the facility. Predisposal storage areas are also found at off-site treatment facilities (Environment Canada, 1988).

The Canadian Standards Association (CSA, 1988) recommends that intermediate and final storage areas should:

a) be totally enclosed;
b) be separate from supply rooms or food preparation areas;

c) have provision for being locked; and
d) have access restricted to authorized personnel only.

Health care facilities that refrigerate stored waste should use:

a) a lockable, closed cold storage facility; or
b) a lockable, domestic type freezer unit that is dedicated to the accumulation of wastes for disposal.

This waste should be stored at a temperature of 4°C or lower, with freezing being the preferred method of storage (CSA, 1988).

Further, all waste storage areas should meet the requirements of the National Building Code and the applicable Provincial building code requirements and should be reasonably sized to accommodate predicted storage needs (CSA, 1988).

## Transportation

(i) On-Site Transportation. In-house transportation might generally be divided into two stages:

1. Transportation of wastes from primary storage to waste holding areas;
2. Transportation of wastes from waste holding areas to one or more predisposal areas.

The first stage is usually managed manually with the help of push or hand carts. The CSA (CSA, 1988) recommends that manual handling of waste materials should be minimized.

The second stage offers a variety of alternatives, depending on the nature of the wastes. These alternatives will be reviewed and their suitability for biomedical wastes will be assessed more specifically. The following systems are offered to the health care industry (Environment Canada, 1988):

a) Manual system
b) Gravity chute - manual system
c) Gravity chute and pneumatic tube system (P.T.S.) or all P.T.S.
d) Self-propelled carts
e) Monorail conveyor and overhand conveyer
f) Conveyor belt

### a) Manual System

This system employs a fleet of the traditional hand carts in a predetermined itinerary around the facility's floors. The worker pushing the cart transfers the wastes from the waste holding areas into the vehicle until it is full. The cart is then wheeled to the central storage area (or predisposal area) where all the waste bags are unloaded. This process is repeated until all the waste holding areas have been emptied. CSA recommends a daily cleaning and disinfecting schedule for the waste management carts (Environment Canada, 1988).

Carts used for transporting biomedical wastes should:

a) be capable of containing the waste;
b) be designed to prevent spills; and
c) be constructed of materials that permit effective cleaning and disinfection.

Open carts could be used for the transfer of biomedical wastes that are enclosed in sealed waste containers.

Specific routes for the movement of wastes should be planned in order to minimize passage through patient care areas and other clean areas (CSA, 1988). Problems associated with this method can be solved through careful planning of the routes, training of the personnel, adequate sizing and construction of the carts.

Advantages: very flexible; can be adapted to any type and quantity of wastes.
Disadvantages: slow; adds to traffic congestion; potential or contaminating the facility environment (Environment Canada, 1988).

b) Gravity Chute - Manual System

A gravity chute is a vertical tube, square or cylinder, usually made of stainless steel or aluminum. It generally has a mechanical exhaust, a sanitizing unit and a fire prevention system. The tube has an access door on each floor located where the bags from the waste holding areas are to be loaded. Backdraft and piston effects are prevented by having an interlockable door system and by maintaining a slight negative pressure within the tube. The wastes accumulate in a cart placed at the bottom of the chute. Once filled, this cart is replaced with an empty one, moved to the predisposal area, unloaded manually and returned to the chute discharging point.

Anatomical and heavily contaminated wastes are not suitable for this type of transportation. The CSA (CSA, 1988) recommends that chutes only be used for general waste purposes only. Good design and construction of the chutes; proper operation and use; and the segregation and proper enclosure of the wastes should eliminate the safety hazards linked with this means of biomedical waste transportation.

Advantages: accelerates collection rate; alleviates traffic in elevators and corridors.
Disadvantages: adds a handling step at the chute access door and sometimes at the chute exit; maintenance operations; fire hazards (Environment Canada, 1988).

c) Gravity Chute Pneumatic Tube System (P.T.S.) or all P.T.S.

The pneumatic tube system (P.T.S.) is a network of vertical and horizontal tubes. A forced air stream carries the loads as they are introduced into the system. The air stream is filtered before being exhausted and the containers are collected in a hopper.

Access to the chute is provided by two doors: an outer door into which waste is dumped and an inner door which provides closure between the charging station and the tube when the outer door is open. The system is programmed so that only one load (or one type of waste) can enter at a time.

The World Health Organization (WHO, 1983) recognizes that "pneumatic pipeline transport systems are used for waste movement in some modern hospitals." But WHO also recommends avoiding the use of this system for "pathological and infectious waste." This permits very limited application of P.T.S. in the management of biomedical wastes.

Advantages: allows for transportation of waste to almost any location in the building; can be installed in existing facilities; capable of horizontal and vertical movement; reduces labour costs considerably.
Disadvantages: frequent mechanical failures; high maintenance; limitation in tube sizing; not recommended for all categories of biomedical wastes, radiological, toxic chemical and flammable solvent wastes; major capital investment.

### d) Self-Propelled Carts

These vehicles are propelled with rechargeable power units and are capable of horizontal and vertical movements. The horizontal directions are controlled by a network of wires, concealed in the floor, and interpreted electronically by the cart. Vertically, the cart is transported by special elevators, again, sensitive to electronic signals emitted by the cart. The carts are dispatched from a central storage area where their programmed destinations can be dialed by an operator. Stops at waste holding areas are also programmed so that maintenance personnel can load the carts with the accumulated wastes.

Features such as manual controls for removing the cart from its original path and an immediate stop when in interference with an obstacle favour its use in buildings like hospitals. Soiled material can be stored in individual bins or on a separate cart for better segregation and minimizing cross contamination. Also, separate elevators should be used for upward and downward movement to minimize the risks of cross contamination.

Although this system is somewhat similar to the manual system, unattended transportation of biomedical wastes remains questionable.

Advantages: decreases the labour requirement.
Disadvantages: dependent on power modules which are expensive; the movements of the cart may be delayed if an obstacle happens to be in its path; high maintenance and planning (Environment Canada, 1988).

### e) Monorail Conveyor and Overhand Conveyor

The monorail conveyor system is a series of motorized transporters suspended from a monorail track and typically, operates within its own confinement, or shaft, except at the loading and unloading stations. Itineraries can be either programmed or improvised upon request. The overhead chain conveyor system uses the overhead tracks for the motive power to move the transporters.

These systems allow for vertical and horizontal movements. Another feature is the bottom access door on the carts allowing for an easy discharge of the waste over the final storage area. Both systems can be cleaned and sterilized through a washer/sterilizer unit installed on-line. Sterilized wastes may be transported, providing that access to the shaft is maintained.

Advantages: automatic unloading; carts less expensive than other automatic handling systems.
Disadvantages: implementation in difficult existing facilities; improper uses possible ; needs an extensive preventive maintenance program.

f ) Conveyor Belts

Boxes or bags containing wastes are moved vertically or horizontally on roller conveyors powered by an endless belt, continuous chain, or by a series of progressive chains. Boxes can be routed through a magnetic reading (such as a bar code system). Like the other systems, access doors strategically located alleviate the circulation congestion.

Again, this system is not recommended for unsterilized wastes or anatomical wastes.

Advantage: allow for movements throughout the facility.
Disadvantages: multi-handling (loading/unloading of container boxes); many conveyors needed; thus, spacing problems (Environment Canada, 1988).

Table A6.1 presents a comparison among the different in-house transportation options discussed above.

(ii) Off-Site Transportation. Off-site transportation is used to move waste to its ultimate disposal site, such as a landfill, or it might be needed when using an off-site treatment facility (centralized sterilizing facility, incinerator or transfer station).

Waste transportation vehicles should be specially designed for biomedical waste use. Adaptation is made to reflect guidelines and regulations, such as the Transportation of Dangerous Goods Regulations, Transport Canada, or its equivalent provincial regulation (Environment Canada, 1988).

## APPENDIX 6.1

## TABLE A6.1

## ADVANTAGES AND DISADVANTAGES OF WASTE TRANSPORTATION SYSTEMS

| Advantages | | Disadvantages |
|---|---|---|
| Very flexible; can be adapted to any type and quantity of wastes.<br>Low capital cost. | MANUAL | Slow.<br>Adds to traffic congestion.<br>High labour cost. |
| Accelerates collection rate.<br>Alleviates circulation in facility.<br>Low capital cost. | GRAVITY CHUTE | Adds a handling step at the chute access door and even at its exit.<br>Fire and blocking hazard.<br>Not advisable for anatomical wastes and sharps. |
| Flexible.<br>Can be installed in existing facilities.<br>Capable of horizontal and vertical. movements.<br>Low labour costs. | PNEUMATIC TUBE | High maintenance.<br>Limitation in tubing size.<br>Not recommended for anatomical wastes and sharps, radiological, toxic chemical and flammable solvent wastes.<br>High capital and maintenance costs.<br>Requires back-up system. |
| Decreases labour costs.<br>Capable of horizontal and vertical movements.<br>Can be used for all types of wastes. | AUTOMATIC CARTS | Depends on expensive power modules.<br>Movements of the carts may be delayed by obstacles.<br>High maintenance and planning.<br>Requires back-up system.<br>High capital costs. |
| Automatic unloading.<br>Carts less expensive than other automatic systems.<br>Low labour costs. | MONORAIL OVERHEAD CONVEYOR | Implementation in existing facilities difficult.<br>High maintenance required.<br>Improper uses possible.<br>Needs an extensive preventive program.<br>High capital costs.<br>Requires back-up system.<br>Not suitable for contaminated material. |
| Allows for horizontal and vertical movements. | CONVEYOR BELT | Multi-handling (loading/unloading of container boxes)<br>Many conveyors needed, thus, spacing restrictions.<br>Not suitable for contaminated material. |

(Environment Canada, 1988)

# APPENDIX 6.2

## 6.2 INCINERATION TECHNOLOGIES

Incineration is a controlled process by which the combustible portion of a waste is burned and changed into non-combustible gases. This is a common method of disposal of biomedical waste in health care and similar facilities. The major objectives of biomedical waste incineration are: (1) to reduce both the mass and volume of the waste, and (ii) to render the waste non-infectious and safe. These are achieved in a properly designed and operated incinerator by exposing the waste to sufficiently high temperatures for long periods of time to ensure complete burning of the combustibles and destruction of all infectious microorganisms.

### Combustion Process

In general and simplified terms, combustion is a process in which the combustible constituents, mainly carbon and hydrogen of the feed material, are chemically combined with oxygen, usually supplied as air into the system, to form carbon dioxide and water vapour. The non-combustible portion of the feed material is transformed into ash. In practice, complete combustion is extremely difficult and virtually impossible to attain.

The combustion efficiency of an incinerator depends mainly on its design and operating parameters; several of the latter parameters are interrelated to the particular design features. As with any combustion system the major factors which influence the combustion performance of an incinerator are: the provision of proper combustion conditions inside the combustion chamber and the characteristics of the waste. Other factors such as fuel feeding system and ash disposal mechanism also affect the performance of an incinerator to a certain extent.

### Combustion Conditions

To achieve complete combustion a sufficient supply of air, normally in excess of theoretical requirement, and adequate provisions for the three T's (Time, Temperature and Turbulence) in the combustion chamber are essential. The designs of efficient combustion systems are based on these premises, although each system has its own particular features to satisfy these requirements.

### Waste Characteristics

Unlike conventional fossil fuels, biomedical waste has characteristics which render it difficult to burn. It is a heterogenous mixture of several kinds of materials, and its physical and chemical composition is highly variable depending on the waste management practices at the particular institution.

### Physical and Chemical Characteristics

Only limited information on the chemical composition of biomedical wastes is presently available in the literature. The Ministry of the Environment in the Province of Ontario carried out a characterization study of various biomedical wastes generated there (Ontario, 1986). Its findings are summarized in Table A6.2 for various waste types, as classified according to the Canadian Standards Association guidelines for "Handling of Waste Materials Within Health Care Facilities." The properties reported are typical

# APPENDIX 6.2

TABLE A6.2

Characterization of Biomedical Waste

| WASTE CLASS | COMPONENT DESCRIPTION | TYPICAL COMPONENT (weight %, as fired) | HIGH HEATING VALUE (dry basis, kJ/kg) | BULK DENSITY (as fired, kg/m³) | MOISTURE CONTENT OF COMPONENT (weight % | WEIGHTED HIGH HEATING VALUE RANGE OF WASTE COMPONENT (dry basis, kJ/kg) | TYPICAL COMPONENT HIGH HEATING VALUE OF WASTE (as fired, kJ/kg) |
|---|---|---|---|---|---|---|---|
| A1 (Red Bag) | Human Anatomical | 95-100 | 18600-27900 | 800-1200 | 70-90 | 1770 - 8370 | 2800 |
| | Plastics | 0-5 | 32500-46400 | 80-2300 | 0-1 | 0-2300 | 400 |
| | Swabs, Absorbants | 0-5 | 18600-27900 | 80-1000 | 0-30 | 0-1400 | 200 |
| | Alcohol, Disinfectants | 0-0.2 | 25500-32500 | 800-1000 | 0-0.2 | 0-70 | 50 |
| | | | | | | | 3450 |
| A2 (Orange Bag) | Animal Infected Anatomical | 80-100 | 20900-37100 | 500-1300 | 60-90 | 1670-14840 | 3500 |
| | Plastics | 0-15 | 32500-46400 | 80-2300 | 0-1 | 0-6960 | 1000 |
| | Glass | 0-5 | 0 | 2800-3600 | 0 | 0 | 0 |
| | Beddings, Shavings Paper, Fecal Matter | 0-10 | 18600-20900 | 320-730 | 10-50 | 0-1880 | 1400 |
| | | | | | | | 5900 |
| A3(a) (Yellow Bag) | Gauze, Pads, Swabs Garrents, Paper Cellulose | 60-90 | 18600-27900 | 80-1000 | 0-30 | 7810-25110 | 15000 |
| | Plastics, PVC, Syringes | 15-30 | 22500-46400 | 80-2300 | 0-1 | 3340-13920 | 7540 |
| | Sharps, Needles | 4-8 | 140 | 7200-8000 | 0-1 | 6-10 | 10 |
| | Fluids, Residuals | 2-5 | 0-23200 | 1000-1020 | 80-100 | 0-230 | 70 |
| | Alcohol, Disinfectants | 0-0.2 | 16200-32500 | 800-1000 | 0-50 | 0-70 | 30 |
| | | | | | | | 22650 |
| A3(b) (Yellow Bag) Lab Waste | Plastics | 50-60 | 32500-46400 | 80-2300 | 0-1 | 16090-27840 | 21000 |
| | Sharps | 0-5 | 140 | 7200-8000 | 0-1 | 0-10 | 0 |
| | Cellulosic Materials | 5-10 | 18600-27900 | 80-1000 | 0-15 | 790-2790 | 1500 |
| | Fluids, Residuals | 1-20 | 0-23200 | 1000-1020 | 95-100 | 0-230 | 70 |
| | Alcohol, Disinfectants | 0-0.2 | 25500-32500 | 800-1000 | 0-50 | 0-70 | 50 |
| | Glass | 15-25 | 0 | 2800-3600 | 0 | 0 | 0 |
| | | | | | | | 22620 |
| A3(c) (Yellow Bag) R & D on DNA | Gauze, Pads, Swabs | 5-30 | 18600-27900 | 80-1000 | 0-30 | 650-8370 | 2300 |
| | Plastics, Petri Dishes | 50-60 | 32500-46400 | 80-2300 | 0-1 | 16090-27840 | 21000 |
| | Sharps, Glass | 0-10 | 140 | 7200-8000 | 0-1 | 0-10 | 0 |
| | Fluids | 1-10 | 0-23200 | 1000-1020 | 80-100 | 0-460 | 230 |
| | | | | | | | 23530 |
| B1 (Blue Bag) | Non-Infected Animal Anatomical | 90-100 | 29000-37100 | 500-1300 | 60-90 | 1880-14840 | 3000 |
| | Plastics | 0-10 | 32500-46400 | 80-2300 | 0-1 | 0-4640 | 2300 |
| | Glass | 0-3 | 0 | 2800-3600 | 0 | 0 | 0 |
| | Beddings, Shavings Fecal Matter | 0-10 | 18600-20900 | 320-730 | 10-50 | 0-1880 | 1400 |
| | | | | | | | 6700 |

NOTE: a (1770kJ/kg) = (0.95 x 18600 x 1-0.9)
b (8370kJ/kg) = (1.0 x 27900 x 1-0.7)

(Ontario, 1986)

component weight percentages and their bulk densities, moisture contents and higher heating values.

One of the major constituents of concern in biomedical waste is the high plastic content, which is reported to vary from 10 to 30%, but is typically about 20 percent (Murnyak and Guzewich, 1982). Although plastics are good combustible substances with high heating values, they are known to contribute towards the formation of hydrogen chloride and toxic contaminants. The most common types of plastic found in biomedical waste are polyethylene, polypropylene and polyvinyl chloride (Doucet, 1986). Polyvinyl chloride contains about 45% chlorine by weight and is the major contributor of this element; other plastics are known to have trace amounts of chlorine only (Kaiser and Carotti, 1972).

From the standpoint of combustion system design and operation requirements, the following properties of biomedical waste are regarded as problematical:

- heterogeneity and variable composition of the waste;
- high moisture and low heating value of the composite waste;
- variable ash content and composition; and
- presence of precursors to the formation of corrosive and toxic substances.

In practice, the feed materials to a biomedical waste incinerator are neither preprocessed nor blended to produce a uniformly mixed feed. Biomedical wastes generated in a health care facility consist of materials of different shapes and sizes having diverse chemical composition. The moisture content of the various components in the mixture vary from zero percent in dry materials to 100 percent in liquid substances. The high heating value of the multitude of components present in the biomedical waste, as shown in Table A6.2, ranges from 0 to 46,400 kJ/kg (dry basis).

Varying amounts of non-combustibles are present in different components of biomedical waste. Such materials consist of glass, ceramics and different metallic objects, and their softening and fusion properties vary considerably which can influence the operating temperature of an incinerator to safeguard against clinker formation, slagging and fouling of the system components.

Corrosive elements, mainly chlorine and some fluorine, which come from waste components such as plastics, contribute to the formation of acid gases which can cause damage to the equipment. In order to avoid such damages the use of corrosion-resistant materials in the equipment construction and proper operating procedures, with respect to temperature and pressure, are essential.

### Microbiological Characteristics

As the biomedical waste may contain infectious materials, it is essential that the microorganisms present therein must be destroyed during combustion to prevent their escape through either the flue gas or the incinerator residue. Investigations by Barbeito and Shapiro (Barbeito and Shapiro, 1977) have indicated that to ensure complete destruction of microorganisms incinerators should have certain minimum design and operating parameters with respect to combustion temperature, preheating of the system, waste charging, and ash retention time in the combustion chamber (Barbeito and Shapiro, 1977). These investigators have recommended the following measures to ensure complete destruction of microorganisms:

- the minimum temperature of 760°C and 870°C in the primary and secondary chambers of an incinerator respectively;
- a minimum preheating period of one-half hour for the secondary chamber before charging any waste;
- in a batch type incinerator only non-infectious waste should be charged during the first one-half hour after the unit is fired-up. Infectious waste should be fed only when the secondary chamber has been preheated.
- to ascertain the minimum temperature and residence time required to destroy microorganisms each incinerator should be tested with bacterial spores; and
- to ensure destruction of microorganisms in the ash it is desirable to provide the ash a long residence time in the primary chamber, and to discharge the ash on a batch basis at the end of each burn cycle which is typically about 4 to 6 hours.

## Incinerator Types (Ontario, 1986 and US EPA, 1987)

As the quantity of biomedical waste generated in health care facilities is relatively small in comparison with typical municipal and industrial waste generation rates, usually small incinerators are used to dispose of this particular type of waste. The size of biomedical waste incinerators range from 30 to 3 000 kg per hour capacity, and most of them are operated on an intermittent, batch mode.

Incinerators currently used to burn biomedical waste can be generally classified into following three types:

- multiple-chamber;
- controlled air; and
- rotary kiln

The basic design and operating features for each of these types are outlined below.

## Multiple-chamber Incinerator

There are two main design configurations for multiple-chamber incinerators, namely the in-line and retort types, as shown in Figures A6.1(a) and A6.1(b). With the exception of a few features, the basic designs are similar in both types of units. As the name implies they have a minimum of three chambers, passes or zones inside, although they appear as a compact unit from the outside.

The primary chamber usually has a solid hearth with a trough or lip of about 5 cm deep to collect liquids. The waste is charged manually into the primary chamber where it is dried, ignited and burned with the aid of an auxiliary burner, combustion air supply and hot chamber walls. The vapourized moisture and volatile constituents from the waste as well as its products of combustion escape from the primary chamber through a flame port into the secondary chamber. Additional combustion air is supplied through the flame port for mixing of the reactants and burning of the remaining combustibles in the secondary chamber. Auxiliary burners are also used to maintain sufficient combustion temperature in the secondary chamber.

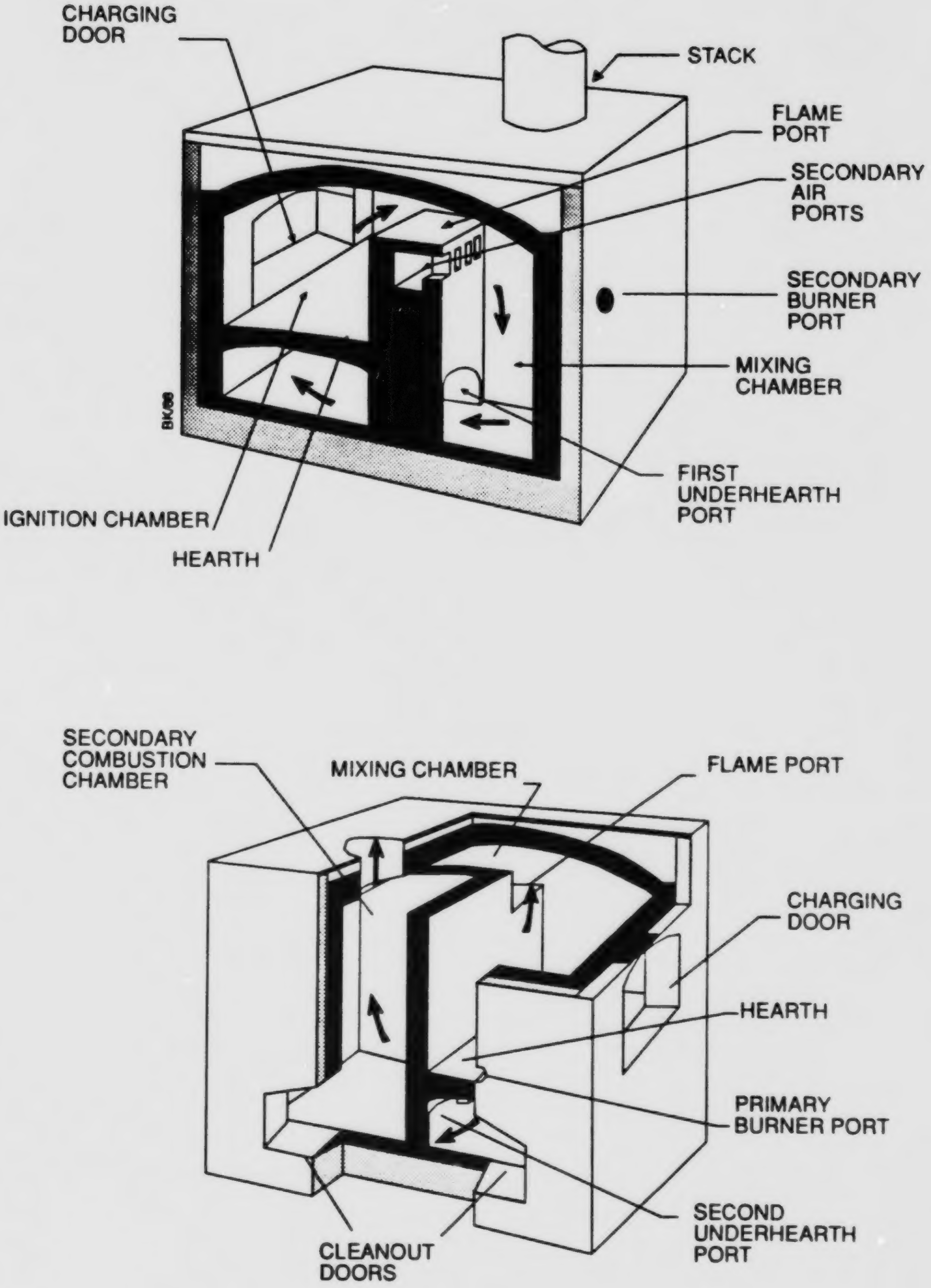
CHARGING DOOR
STACK
FLAME PORT
SECONDARY AIR PORTS
SECONDARY BURNER PORT
MIXING CHAMBER
FIRST UNDERHEARTH PORT
IGNITION CHAMBER
HEARTH
BK/88
SECONDARY COMBUSTION CHAMBER
MIXING CHAMBER
FLAME PORT
CHARGING DOOR
HEARTH
PRIMARY BURNER PORT
SECOND UNDERHEARTH PORT
CLEANOUT DOORS

**FIGURE A6.1 (a) RETORT TYPE MULTIPLE CHAMBER PATHALOGICAL WASTE INCINERATOR**

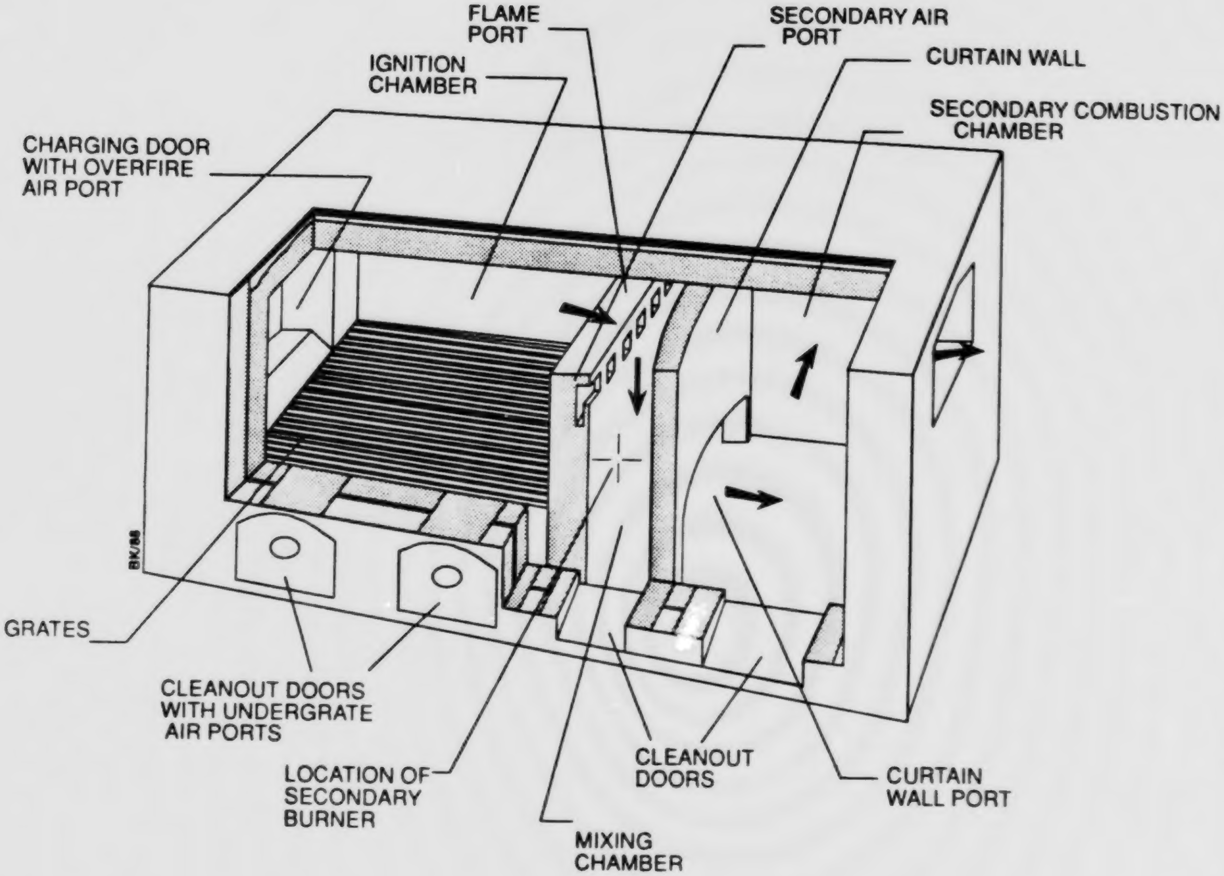
FLAME PORT
SECONDARY AIR PORT
IGNITION CHAMBER
CURTAIN WALL
SECONDARY COMBUSTION CHAMBER
CHARGING DOOR WITH OVERFIRE AIR PORT
BK/88
GRATES
CLEANOUT DOORS WITH UNDERGRATE AIR PORTS
LOCATION OF SECONDARY BURNER
CLEANOUT DOORS
CURTAIN WALL PORT
MIXING CHAMBER

**FIGURE A6.1 (b) IN-LINE TYPE MULTIPLE CHAMBER INCINERATOR**

The in-line incinerators are designed so that the product gases from the primary combustion chamber pass through a mixing chamber to the secondary combustion chamber and out of the unit with 90-degree turns in both vertical and horizontal directions. These features of gas flow patterns allow increased mixing of air and gases to ensure proper combustion, and also reduce the entrainment of particulate matter in the exhaust gas.

Both types of multiple-chamber incinerators are operated in an excess air mode at total excess air levels in the range of 150 - 400 percent, depending on the type of waste burned. The air is usually supplied by natural draft and introduced into the combustion chambers through manually-operated ports. The air supply is controlled by barometric dampers which are considered to be not so efficient because of their slow response to any changes.

Some in-line type units have an open grate hearth and, thus, are unsuitable for burning wastes with high fluid content. A separate solid hearth can, however, be incorporated in these units to burn such wastes. The combustion of wastes in multiple-chamber incinerators is best achieved by frequent small charges of waste spread across the hearth in a single layer and by providing steady heat through the use of auxiliary burners. Multiple-chamber incinerators are usually operated intermittently, and the ash from the hearth is removed manually as required.

Although these incinerators have been used to dispose of biomedical waste, the increasing concern over the waste characteristics and the potential generation of toxic pollutants during combustion is likely to place severe limitations on their future use. This is particularly so in view of the fact that the design and operating features of other types of incinerators appear to be superior to multiple-chamber units.

### Controlled Air Incinerator

Controlled air incinerators have become the most commonly used systems for burning biomedical and other types of wastes in recent years. These are also referred to as modular incinerators, as various components of a unit are assembled and packaged in the factory for immediate on-site installation, except for the necessary utility connections. This type of incinerator is usually dual-chambered - a primary chamber in which the waste is fed and combusted, either partially or fully, and a secondary chamber or an afterburner where the combustion process is completed. The term "controlled air" emanates from the design feature of the air supply into the primary chamber. Depending on the manner of air supply into the primary chamber, these incinerators are classified as either starved (sub-stoichiometric) air or excess air units.

Typical configurations of controlled air incinerators are illustrated in Figure A6.2. In both types of units, the waste can be fed into the primary chamber either manually or by mechanical devices. The primary chamber in both types of incinerators is heated by one or two auxiliary burners to dry, volatilize and ignite the waste. In starved air units, the waste is partially oxidized by providing less than the stoichiometric quantities of air required for complete combustion. A typical air supply ranges from 30 to 80% of the stoichiometric requirement and results in partial combustion of the waste with the production of pyrolitic gases and chars. In excess air type units, the air supply into the primary chamber typically ranges from 160 to 300% of the stoichiometric requirement to allow almost complete combustion of the waste to take place. The temperature in the primary chamber is usually maintained between 400 and 870° C, depending on the type of the unit.

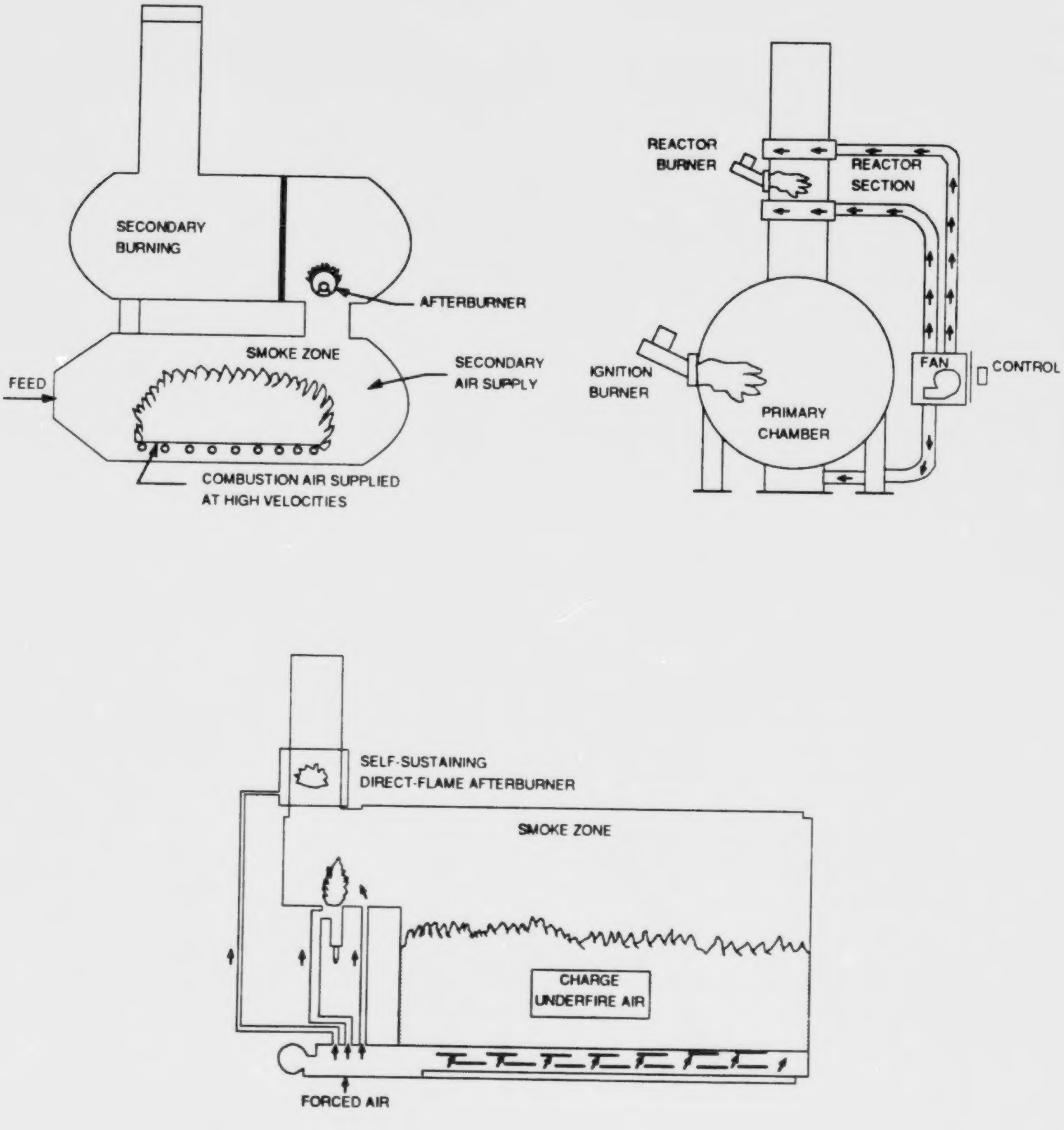
SECONDARY BURNING
AFTERBURNER
SMOKE ZONE
FEED
SECONDARY AIR SUPPLY
COMBUSTION AIR SUPPLIED AT HIGH VELOCITIES
REACTOR BURNER
REACTOR SECTION
IGNITION BURNER
FAN
CONTROL
PRIMARY CHAMBER
SELF-SUSTAINING DIRECT-FLAME AFTERBURNER
SMOKE ZONE
CHARGE
UNDERFIRE AIR
FORCED AIR

FIGURE A6.2: TYPICAL CONFIGURATIONS OF CONTROLLED AIR INCINERATORS

The product gases leaving the primary chamber flow into the secondary chamber for further combustion. In starved air incinerators, the secondary chamber is preheated by an auxiliary burner to ignite the incoming gases and additional air, usually between 40 and 250% of the total excess air, is supplied to complete the combustion. As the combustion progresses and the desired temperature in the chamber is reached, the auxiliary burner is automatically shut off until it is again needed to sustain the appropriate temperature. In the excess air incinerator, usually no auxiliary burner is needed in the secondary chamber, as the high temperature of the entering gases and the supply of some additional air is sufficient to sustain combustion. However, a burner is installed in this chamber in the event of the need to maintain the minimum desired temperature. The operating temperature of the secondary chamber can be as high as 1100°C, and the gas residence time typically ranges from 0.25 to 2.0 seconds.

Ash removal from controlled air incinerators can be manual or by mechanical devices, depending on the unit size. The unit size ranges from 34 to 2 950 kg/h, and standard models can be adjusted to suit specific needs. Smaller sizes are normally batch fed, and larger units can be charged continuously by mechanical feeding devices such as a screw feeder.

The combustion control systems, in particular air supply, temperature and burners in both types of incinerators, are usually controlled automatically; hence, the responses to malfunctions are fast and the combustion efficiency is high. Because of the lesser chance of fuel bed disturbances and particulates entrainment in the flue gases in a starved air unit than that observed in an excess air incinerator, the former type appears to be more widely used to burn various types of wastes.

### Rotary Kiln Incinerator

The use of rotary kilns to incinerate biomedical waste is relatively new, although this technology has been applied successfully in several industries to burn various solids and liquids. The major components of the rotary kiln incinerator are the primary chamber in which the waste is charged and burned, and either an afterburner section or a separate secondary chamber in which the combustion of the remaining combustibles is completed. Typical arrangements of these types of incinerators are shown schematically in Figure A6.3.

The primary chamber is a horizontal, refractory-lined cylindrical rotating kiln. The ratio of length to diameter of the kiln usually ranges from 2:1 to 10:1. It is mounted at a slight incline to allow the waste feed to travel from the charging end to the ash discharge end as it rotates horizontally. The speed of rotation of the kiln is variable and can be adjusted to suit a particular requirement. Feeding of the waste can be either manual or by hopper-ram arrangement, and the waste burning rate is controlled by the incline of the kiln and its rotational speed. The combustion air is supplied into the primary chamber where an auxiliary burner is used for preheating the chamber, igniting the waste, as well as for maintaining the desired combustion temperature.

The volatiles and the remaining combustibles in the product gases from the primary chamber are either burned in an afterburner section at the discharge end of the kiln or passed through a secondary chamber. The secondary chamber is usually refractory-lined and equipped with an additional air supply system and another burner. Typical operating temperatures for these incinerators range from 800°C to 1200°C, although

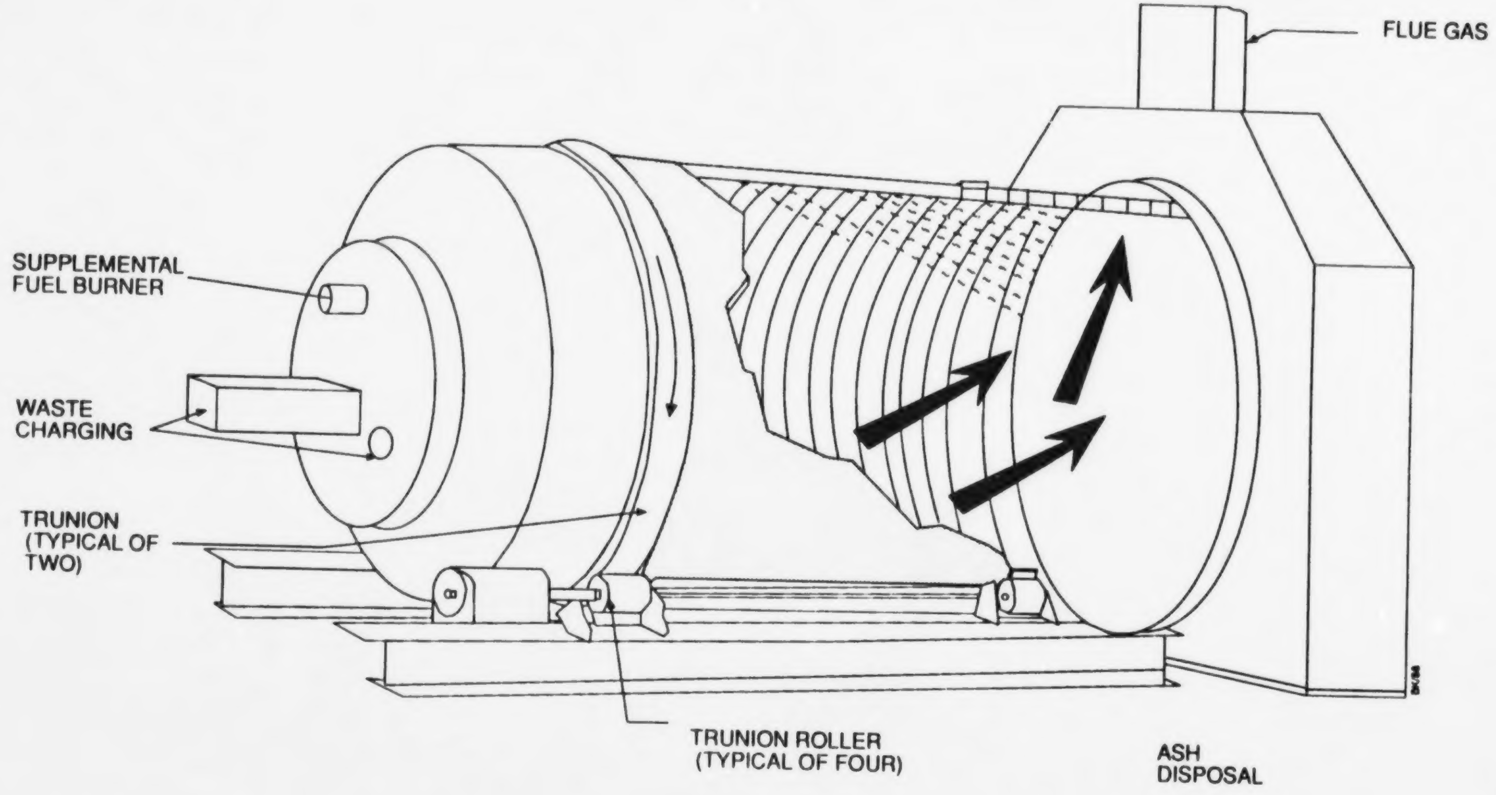
FLUE GAS
SUPPLEMENTAL FUEL BURNER
WASTE CHARGING
TRUNION (TYPICAL OF TWO)
TRUNION ROLLER (TYPICAL OF FOUR)
ASH DISPOSAL

FIGURE A6.3: SCHEMATIC DIAGRAM OF A THE ROTARY KILN

temperatures in excess of 1400°C can be attained during operation because of their construction.

Rotary kilns have several design features, in particular, the refractory-lined chambers and control of waste burning rate, suitable for incinerating biomedical waste. The waste can be exposed to high temperatures for a variable length of time and the reactants are well mixed because of the rotary action. However, there is potential for air leakages into the primary chamber, hence some reduction in thermal efficiency, through the end seals of the kiln. Also, due to turbulence inside the kiln, the entrainment of particulates in the flue gases is reported to be higher than the levels observed in other types of incinerators.

## Pollution Aspects of Incineration

As far as pollution is concerned, incineration of waste can generate secondary pollutants unless appropriate control measures are taken to minimize their impacts. A detailed review of the pollution aspects of incineration is beyond the scope of this report; hence, a brief overview is presented here only.

The major pollution of concern associated with waste incineration is the emission of contaminants into the atmosphere. The characteristics of the ash generated from the waste may be of some concern in some cases, and may pose disposal problems. Additional solid residues and/or wastewater are also produced where a control system is employed to reduce the level of emissions.

## Emission Characteristics

There is a lack of information in the literature on the characteristics of emissions from incineration of biomedical waste. As it is a common practice to incinerate this waste along with other hospital wastes, the information available is mostly related to hospital waste in general. It should be noted that with the exception of the infectious substances, both biomedical waste and the general hospital waste contain similar substances which contribute to the generation of certain contaminants during incineration. Other contaminants produced are inherent to the incineration process itself, and their generation depends on the design and operation of the equipment.

The contaminants of concern which are known to be present in the emissions from incinerators burning hospital waste containing biomedical waste consist of the following:

| | |
|---|---|
| Major contaminants | Particulates, carbon monoxide, hydrocarbons |
| Acid gases | Hydrogen chloride, sulphur oxides, nitrogen oxides, hydrogen fluoride |
| Trace metals | Arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, vanadium, zinc |
| Trace organics | Polycyclic aromatic hydrocarbons, halogenated dioxins and furans |
| Others | Pathogens, viruses |

Apart from pathogens and viruses, all other contaminants listed above are qualitatively similar to those usually present in the flue gases from small modular municipal waste incinerators of controlled air types, which are also the most common types used to incinerate hospital wastes.

The ranges of emissions of contaminants from hospital incinerators and modular municipal waste incinerators are summarized in Tables A6.3 and A6.4 respectively. Because of the lack of detailed monitoring information provided in the literature, the data presented in Table A6.3 have not been normalized to any particular reference conditions such as those presented in Table A6.4. Therefore, some caution should be exercised when the data from these tables are compared.

As evident from Table A6.3, only limited data are available for controlled emissions from hospital waste incinerators. It is interesting to note that all controlled emission test results are only from two sources reported in 1987. One of these sources (Powell, 1987) provided data for particulates and hydrogen chloride emission levels from two incinerators fitted with acid gas control equipment. Another (Jenkins, 1987b) reported results of tests from one incinerator equipped with a dust control system only; however, this system also provided controlled emission levels of several trace metals and trace organics. As for the emissions from municipal incinerators provided in Table A6.4, all data are for uncontrolled emissions with the exception of the lowest particulates level of 142 mg/m3.

## Wastewater Characteristics

The use of a wet scrubber to remove particulates and/or acid gases from the incinerator flue gas is most likely to generate wastewater at the site. There is no readily available information on the quality of such effluent from the wet scrubbers. Depending on the scrubbing medium used, the effluent would be alkaline, acidic or neutral. It would contain suspended and dissolved fly ash particles, as well as trace metals and trace organics in solution and/or as fine particles. Therefore, it is unlikely that the spent scrubber liquid can be discharged to the environment without any treatment.

Where the incinerator ash is discharged by a wet method using a water quench system, there would be another wastewater stream which may require treatment prior to disposal.

## Ash and Residue Characteristics

The non-combustible portion of the waste is transformed into ash by incineration, most of which remains on the hearth as the bottom ash, and the rest is carried away as fly ash particles by the flue gas. As the combustion of the waste is never complete in practice, both ash fractions do contain some products of incomplete combustion in the form of trace organics. Where an economiser, a boiler or a particulates control device is used downstream of the incinerator, some fly ash particles are collected in them and the remainder is discharged into the atmosphere with the flue gas.

If a wet scrubber is used to control particulates emission, the fly ash collected in the scrubber would be mixed with the scrubbing solution. A dry dust control device would generate fly ash only, but a dry scrubber-dust collector combination would produce a dry residue of fly ash and spent sorbent for acid gases.

There is hardly any information in the literature on the characteristics of these ashes from hospital waste incinerators. Based on the limited data available for the municipal waste incinerator ash properties, it appears that while the bottom ash may not pose any disposal problem, the fly ash requires careful handling. Fly ash from municipal waste incinerators consists of fine particles enriched with trace metals and trace organics of a

# APPENDIX 6.2

## TABLE A6.3

## Ranges of Emissions of Various Contaminants from Hospital Incinerators

| Contaminant | Emission Range |
|---|---|
| (in mg/m$^3$) | |
| Particulates | 2.3-391 mg/m$^3$ uncontrolled emission<br>46-92 mg/m$^3$ controlled emission |
| Sulphur dioxide ($SO_2$) | 66.5-133 mg/m$^3$ uncontrolled |
| Nitrogen oxides (as Nitrogen dioxide, $NO_2$) | 306-516 mg/m$^3$ uncontrolled |
| Hydrocarbons (HC) | 0.67-4.65 mg/m$^3$ uncontrolled |
| Carbon monoxide (CO) | 58-198 mg/m$^3$ uncontrolled |
| Hydrogen chloride (HCℓ) | 5.4-3179 mg/m$^3$ uncontrolled<br>39-98 mg/m$^3$ controlled |
| Arsenic (As) | 2.3-9.2 µg/m$^3$ uncontrolled<br>0.0018-0.002 µg/m$^3$ controlled |
| Cadmium (Cd) | 57-320 µg/m$^3$ uncontrolled<br>0.24 µg/m$^3$ controlled |
| Chromium (Cr) | 4.9-70.7 µg/m$^3$ uncontrolled<br>0.04-0.016 µg/m$^3$ controlled |
| Iron (Fe) | 149-668 µg/m$^3$ uncontrolled<br>1.1-1.2 µg/m$^3$ controlled |
| Manganese (Mn) | 6.9-41.4 µg/m$^3$ uncontrolled<br>0.24-0.26 µg/m$^3$ controlled |
| Nickel (Ni) | 5.1-18.3 µg/m$^3$ uncontrolled<br>0.11-0.12 µg/m$^3$ controlled |
| Lead (Pb) | 1217-2723 µg/m$^3$ uncontrolled<br>0.49-0.7 µg/m$^3$ controlled |
| Total chlorinated dibenzo-p-dioxins (PCDD) | 52-450 ng/m$^3$ uncontrolled<br>129-130 ng/m$^3$ controlled |
| Total chlorinated dibenzofurans (PCDF) | 117-785 ng/m$^3$ uncontrolled<br>106-435 ng/m$^3$ controlled |

(Bumbaco, M.J. 1983; Darling, C. et al. 1986; Jenkins, A. 1987a; Jenkins, A. 1987b)

# APPENDIX 6.2

## TABLE A6.4

### Ranges of Uncontrolled Emissions of Various Contaminants from Modular Municipal Solid Waste Incinerators

| Contaminant | Range of Emission Concentration[1] |
|---|---|
| (in mg/m$^3$) | |
| Particulates | 142[2] - 303 |
| Hydrogen chloride (HCℓ) | 241 - 1165 |
| Sulphur dioxide ($SO_2$) | 162 - 232 |
| Nitrogen oxides (as Nitrogen dioxide, $NO_2$) | 493 - 591 |
| Carbon monoxide (CO) | 38 - 78 |
| (in µg/m$^3$) | |
| Arsenic (As) | 9.4 - 116 |
| Beryllium (Be) | 0.11[3] |
| Cadmium (Cd) | 238 - 1450 |
| Chromium (Cr) | 0.27 - 394 |
| Mercury (Hg) | 130 - 1080 |
| Nickel (Ni) | 109 - 873 |
| Lead (Pb) | 8400 - 24300 |
| (in ng/m$^3$) | |
| Total chlorinated dibenzo-p-dioxins (PCDD) | 62 - 227 |
| Total chlorinated dibenzofurans (PCDF) | 95 - 250 |

[1]. Concentrations are corrected to 12% $CO_2$ at 20°C and 101.3 kPa.
[2]. Controlled emission after electrostatic precipitator.
[3]. Data available for one test.

(B.C. MOEP, 1987)

toxic nature, and it also tends to generate harmful leachate (NITEP, 1987; Washington, 1986).

Based on the recently available information on the characteristics of the ash and residue materials generated in municipal waste incinerators, it appears that there is a potential for harmful leachate generation from the fly ash and the dry scrubber residue (NITEP, 1987). Until more information becomes available on the ash/residue properties, it would be prudent to require leachate and toxicity tests for these materials, as well as to dispose of them in separate and controlled landfills.

## Emission Control

Measures to control and/or eliminate some of the above contaminants include source separation, waste sterilization, combustion control and flue gas treatment. Any one or a combination of these measures can be implemented to reduce the level of emissions of certain contaminants to the acceptable levels.

By proper segregation of wastes at the source of generation, both the quality and quantity of waste for incineration can be reduced. Such a practice can, to a certain extent, remove specific substances which are known precursors of contaminants of concern from the waste stream before incineration. For example, by reducing the amount of plastics in the waste, particularly polyvinyl chloride plastics, it is most likely that the emission levels of hydrogen chloride and halogenated trace organics in the incinerator flue gas can be reduced. Similarly, sterilization of certain waste components can be practised to render them harmless for disposal with the general refuse.

As it is evident from Tables A6.3 and A6.4, there are wide variations in the uncontrolled emission levels of the contaminants from the incinerators. These variations are partly due to the differences in the design and operation of various equipment. Incinerators can be designed and operated in such a way that contaminants such as particulates, nitrogen oxides, trace metals, and trace organics can be reduced significantly. To date, combustion control has been the most widely practised method to lower the emission levels of these contaminants from both hospital waste and municipal waste modular incinerators.

The flue gas treatment by add-on control equipment to reduce emission levels of contaminants from hospital waste and controlled air municipal waste incinerators is not generally in vogue. As discussed earlier, only a few such installations have been mentioned in the literature. This is presumably because, until recently, there has not been much concern about toxic contaminants and hydrogen chloride emissions, and also due to the economic reasons of installing costly control devices on relatively small incinerators.

Presently, two types of equipment to control emissions from hospital incinerators are in use. Wet scrubbers are used in a few facilities in Alberta (Powell, 1987) to control hydrogen chloride and particulates. At one hospital in California (Jenkins, 1987b), baghouses are used to control particulates. Both these systems have advantages and disadvantages as neither can control all contaminants of concern to safe levels. While wet scrubbers can reduce the levels of acid gases, (mainly hydrogen chloride and some sulphur dioxide) and particulates effectively, they are not nearly as efficient in controlling fine particulates, trace metals, and trace organics. Wet scrubbers also generate wastewater which requires treatment prior to disposal. Baghouses or fabric filters are efficient in reducing particulates including the fine particles, and as the latter are known to be enriched with trace metals and trace organics, these contaminants are also removed to a certain extent from the flue gas. Baghouses, as such, do not control gaseous contaminants, and due to typically high acid gas content of the hospital waste flue gas, condensation of acids can lead to serious problems.

The best available control technology for controlling the majority of contaminants of concern would be the dry scrubber system using acid gas scrubbing reagent and fabric filters. This combination can effectively control acid gases, particulates, trace metals and trace organics from municipal waste incinerators.

## Capital Costs

As the majority of the incinerators used in hospitals are small units without any air pollution control equipment, there is a dearth of information on the costs of such equipment in the literature. Similar situations exist for small municipal waste incinerators, as add-on emission control systems are generally used in units larger than about 45 tonnes/day capacity. No particular attempt has been made to obtain information from equipment suppliers, as a detailed study on costs is beyond the scope of this report. Moreover, incinerator and emission control costs are site specific, and dependent on a number of factors, such as the technology selected for a project, plant size, site preparation, environmental standards to be achieved, etc.

In general, the capital cost of modular controlled air incinerators increases as the capacity of the unit decreases in terms of cost per tonne, of waste per day basis. The information supplied by one equipment vendor indicates that the FOB factory price of such units in US funds varies from $22,060 per tonne for a 11 tonne/day capacity to $11,900 per tonne for a 45 tonne/day capacity (B.C. MOEP, 1988). Other associated costs, such as land, site preparation, utilities, etc., are site specific. The operating costs of an incinerator would also vary from one location to another.

The capital cost of an emission control system is dependent not only on the type of equipment, but also on the contaminants to be controlled and the levels of control necessary. However, irrespective of the control system type the cost of controlling particulates increases significantly as the incinerator capacity decreases. It has been reported that in the case of some small units, such cost may exceed 50% of the cost of the incinerator (New Jersey, 1983). The capital costs of wet scrubbers for controlling acid gases and particulates from hospital waste incinerators have been reported to range from 33% to 56% of that of the incinerators (Alberta, 1988).

The cost of the best available control technology, namely dry scrubber and fabric filter, to control primarily particulates and acid gases from controlled air incinerators of sizes less than 45 tonnes/day capacity has been reported to range from 139% to 180% of the the cost of the incinerator. This cost, however, includes the cost of a quench tower necessary for preconditioning of the flue gas prior to its entry into the dry scrubber. The cost of the control equipment relative to that of the incinerator increases as the capacity of the latter becomes smaller.

No information on the operating costs of either an incinerator or emission control equipment can be provided realistically, as such costs are entirely site specific. It should also be noted that any acid gas removal system would incur additional costs associated with chemical reagent use, as opposed to particulates control devices only.

## Energy Recovery Potential

The overall thermal efficiency of an incinerator system can be improved by recovering the thermal energy normally lost through discharge of the flue gases. This energy can be recovered from controlled air and rotary kiln incinerators by installing waste heat boilers for the purposes of generating steam and hot water for local consumption. A portion of the heat can also be used to preheat the air supplied to the incinerator, and thus to increase its combustion efficiency. However, the relatively small quantity of biomedical waste generated in a typical facility usually precludes an incinerator to be operated continuously, and the waste heat recovery from a batch-operated unit is not practical in most circumstances. Another major disincentive to any waste heat recovery may also be the locally available cheaper alternate energy supply, despite the fact that the energy is wasted through the incinerator flue gases.

In order for energy recovery from this source to be attractive, it is worthwhile operating an incinerator on a continuous basis either by burning biomedical waste along with the general refuse from the facility or by installing a centralized unit to incinerate biomedical wastes from several institutions in and around the area. It is a recognized fact that, in general, the control of emissions from a continuously operated large facility is relatively easier and more cost-effective than that from a small intermittently operated incinerator. Moreover the savings from the recovered energy for use at the site and the additional revenue which could be generated from the sale of any excess energy would partially offset the operating costs for the incinerator.

## Emission Regulations and Strategies

Because of the relatively small sizes and batch operation of biomedical and hospital waste incinerators, emissions from these facilities have not been subject to any specific regulations or standards at the Federal or Provincial level. In the U.S.A. and Europe, emissions from hospital waste incinerators have not been regulated for the same reasons. It is only recently due to growing concern over potential emissions of acid gases and toxic contaminants from these facilities, that several jurisdictions are in the process of developing emission limits applicable to hospital waste incinerators.

In the absence of any specific emission regulations for hospital waste incinerators, various regulatory agencies have been using the existing regulations for municipal waste incinerators. Summaries of the available information on these regulations in Canada and other jurisdictions are presented in Tables A6.5 and A6.6, respectively. It is to be noted that the majority of these regulations are applicable to incinerators of capacity much larger than those mostly used to burn hospital waste. Several agencies are also reviewing their regulations with a view to revise emission limits for various contaminants to reflect the currently available control technologies as well as to address the growing public concern over waste incineration.

The existing Provincial emission objectives for municipal waste incinerators are presently being revised, and new guidelines are expected to be issued in the near future. A Federal-Provincial committee established by the Waste Committee of the Canadian Council of Resource and Environment Ministers (CCREM) recently developed national operating and emission guidelines for municipal solid waste incinerators (CCREM, 1988a; CCREM, 1988b). These guidelines are currently being edited prior to the release of the final CCREM report and as such were unavailable for inclusion in the Task Force's report.

# APPENDIX 6.2

TABLE A6.5

Summary of Municipal Waste Incinerator Emission Regulations in Canada

| Contaminants | British Columbia | National[1] | Alberta | Manitoba | Quebec | New Brunswick | Newfoundland | Ontario |
|---|---|---|---|---|---|---|---|---|
| Particulates ($mg/m^3$) | 230 | 0.75 g/kg of waste | 0.2 kg/1000 kg of flue gas[6]<br>0.6 kg/1000 kg of flue gas[7] | 230 | 150g/100kg refuse[11]<br>270mg/$m^3$ [12]<br>100g/100kg refuse[13] | [9] | 100 | Regulated by Ambient Air Quality Criteria for the Contaminants |
| Opacity (%) | 20[2] | 0[4] | 20[8] | 40[10] | 20 | 20[14] | | |
| Hydrogen chloride ($HCl$) ($mg/m^3$) | [3] | 152[5] | 152[5,9] | | 500 | | 100 | |
| Sulphur dioxide ($SO_2$) ($mg/m^3$) | [3] | 665[5] | 665[5,9] | | | [9] | | |

Note: Alberta, Quebec and Newfoundland apply their regulations to hospital waste also.

[1]. For new packaged incinerators of capacity less than 900 kg/h.

[2]. Variance to 40% opacity allowed for 5% of operating time.

[3]. Other emissions such as chlorides, metal oxides, etc. must not exceed the most restrictive objective set for various industries by the Pollution Control Board. Toxic or odorous compounds must not be emitted in sufficient concentrations to constitute a health hazard or an objectionable odour outside the plant boundary. For smaller operations, one only of the listed parameters may be specified.

[4]. 0% opacity applies to new facilities, 20% opacity limits applied to existing facilities.

[5]. Corrected to 50% excess air.

[6]. For units greater than 227 kg/h.

[7]. For units less than 227 kg/h.

[8]. 20% limit applies to new facilities. 40% opacity for existing facilities.

[9]. Should meet ambient air quality standards.

[10]. 40% at any time, or 20% for a period exceeding 4 minutes in any one hour.

[11]. Less than 1 tonne/hour capacity

[12]. Greater than 1 tonne/hour capacity

[13]. Limits for new incinerators for pathological refuse

[14]. 20% limit applies, except that for an aggregate period of not more than four minutes during one-half hour, smoke may have a density greater than 20% but not exceeding 40%.

(B.C. MOEP, 1987; Environment Canada, 1981; Environment Canada, 1988; Ontario, 1985)

# APPENDIX 6.2

TABLE A6.6

SUMMARY OF RECENT MSW INCINERATOR EMISSION REGULATIONS* IN OTHER JURISDICTIONS

| Contaminant | Denmark (1986) | France (1984-85) | Italy (1985) | Netherlands (1984) | Norway (1986) | Sweden (1986) | Switzerland (1984) | West Germany (1986) | California (1986) | Connecticut (1986) | Michigan (1986) | New Jersey (1986) | New York (1986) | Pennsylvania (1986) | Texas (1987) | Washington (1986) | Japan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Particulates | 40 | 130-875 | 40 | 88 | 100 | 17 | 50 | 41$^{1}$ | 23 | 35 | 35 | 46 | 46 | 28 | 46 | 38$^{12}$ | 35 |
| Opacity | | | | | | | | | | | | | | | | 5%$^{13}$ | |
| Hydrogen chloride (HCl) | 100 | <83 | 50$^{1}$ | 1000 | 100 | 125 | 30 | 69$^{3}$ | 46 | 76 | 6 | 64$^{8}$ | 76 | 6 | 76 | 64 | <700 |
| Hydrogen fluoride (HF) | | | 3$^{2}$ | 20 | | | 5 | 3$^{3}$ | | | | | | | | | |
| Sulphur dioxide ($SO_2$) | 300 | | | 600 | | | 500 | 275$^{3}$ | 80 | $^{4}$ | 229 | 221$^{9}$ | | | 266 | 64 | |
| Nitrogen oxides (NOx as $NO_2$) | | | | 300 | | | 500 | | | $^{4}$ | 595 | | | | | | 478 |
| Carbon monoxide (CO) | | <0.1% | | | | 83 | 100 | 138$^{7}$ | | $^{5}$ | 132$^{7}$ | | 10 | 97$^{11}$ | | | |
| Hydrocarbons (HC as $CH_4$) | | <9 | | | | | | | | | | | | | | | |

* Including standards, objectives, guidelines, etc. Concentrations expressed as mg/m³ at standard conditions of 20°C and 101.3 kPa, and corrected to 12% $CO_2$, unless otherwise stated.

1. 100 mg/m³ for small units (no information on the size limit is available);
2. Total of HF and HBr. For small units the total limit is 5 mg/m³ (no information on the size limit is available);
3. Wet basis;
4. 0.14 mg/kJ of heat input for $SO_2$ and $NO_x$;
5. Limited by the ration of $CO/CO_2$ = 0.002;
6. 90% reduction;
7. 24-h average value;
8. Or 90% reduction;
9. Or 70% reduction;
10. Combustion efficiency of 99.5%;
11. 4-d average;
12. For >227 tonnes/day units. 57 mg/m³ for <227 tonnes/day units;
13. Measured visually. Average of 6 consecutive minutes in any 60-minute period.

(B.C. MOEP, 1987)

In the U.S.A., the Environmental Protection Agency is in the process of developing the new source performance standards for municipal waste incinerator emissions, and the anticipated date of promulgation is December, 1990. However, the agency issued operational guidelines for the existing incinerators in 1987 to aid the State and local agencies. Several State and local regulatory agencies have already developed or are in the process of developing their own emission and operational guidelines, as the existing Federal standards are applicable to incinerators above 45 tonnes/day capacity only.

As far as emission regulations from hospital waste incineration are concerned, in Canada there are no national guidelines and among the Provinces only Alberta, Quebec and Newfoundland have some regulations, as indicated in Table A6.5. The Province of Ontario has recently issued design and operational criteria for biomedical waste incinerators (Ontario, 1986).

The available information on the emission regulations for hospital waste incinerators from jurisdictions outside Canada are summarized in Table A6.7. Due to lack of sufficient information the emission limits have not been normalized to any particular reference conditions. Some caution should, therefore, be exercised during any comparison of these regulations. In addition to the emission limits, the proposed regulations of the States in the U.S.A. also specify various design and operational requirements.

# APPENDIX 6.2

Table A6.7

Summary of Hospital Waste Incinerator Emission Regulations*

| Jurisdiction | Unit Capacity (kg/h) | Contaminant ($mg/m^3$) | | | | |
|---|---|---|---|---|---|---|
| | | Particulates | Hydrogen chloride | Carbon monoxide | Sulphur dioxide | Opacity |
| Connecticut | | 46 (@ 12% $CO_2$) | | | | |
| Illinois | < 907 | 230 -460 (@ 12% $CO_2$) | | | | 30% |
| | > 907 < 2724 | 184 (@ 12% $CO_2$) | | | | 30% |
| | > 2724 | 115 (@ 12% $CO_2$) | | | | 30% |
| New Jersey | | 46 (@ 12% $CO_2$) | | | | |
| New York[1] | | 35 (@ 7% $O_2$) | 76 or 90% reduction | 116 (1-h avg. @ 7% $O_2$) | | Less than 10% during any 6-minute period, except a max. of one 6-minute period/hour of less than 20% |
| Pennsylvania[1] | < 227 | 184 (@ 7% $O_2$) | < 1.8 kg/h or 90% reduction by weight on an hourly basis | 116 (1-h avg. @ 7% $O_2$) | | Less than 10% for a period or an aggregated period of 3 minutes/hour, or less than 30% at any time |
| | > 227 < 907 | 69 (@ 7% $O_2$) | 46 (1-h avg. (@ 7% $O_2$) or 90% reduction by weight on an hourly basis | 116 (1-h avg. @ 7% $O_2$) | 80 (1-h avg. @ 7% $O_2$) or 75% reduction by weight (8-h avg.) | Less than 10% for a period or an aggregated period of 3 minutes/hour, or less than 30% at any time |
| | > 907 | 35 (@7% $O_2$) | 46 (1-h avg. (@ 7% $O_2$) or 90% reduction by weight on an hourly basis | 116 (1-h avg. @ 7% $O_2$) | 80 (1-h avg. @ 7% $O_2$) or 75% reduction by weight (8-h avg.) | Less than 10% for a period or an aggregated period of 3 minutes/hour, or less than 30% at any time |
| Tennessee[1] | | 230 (@ 12% $CO_2$) | 70 (24-h avg.) | | | Less than 10% (6-minute avg.), except for one 6-minute period/hour of less than 20% |
| European (unnamed) | | 200 (@ 7% $CO_2$) | 300 (@ 7% $CO_2$) | 500 (@ 7% $CO_2$) | 200 (@ 7% $CO_2$) | Not to exceed 30% |

* Most jurisdictions also have various requirements for incinerator design, operation and monitoring. Minimum combustion chamber temperature and residence time for gases are specified in most cases. Several regulations require continuous monitoring of combustion parameters and hydrogen chloride.

State of Pennsylvania requires an extensive source testing for various contaminants including trace elements and trace organics at least once a year or as prescribed by the Department.

[1]. Proposed draft regulations.

(USEPA, 1987; New York, 1988; Pennsylvania, 1988; Tennessee, 1988)

# APPENDIX 6.3

## 6.3. BIOMEDICAL WASTE TREATMENT TECHNOLOGIES

### Introduction

The following is a listing of non-incineration treatment options differing in their stage of development between experimental and demonstrated technology which have potential application to selected categories within the biomedical waste stream:

1. Sterilization by steam (autoclave)
2. Sterilization by dry heat
3. Sterilization by chemical vapour
4. Sterilization by irradiation
5. Physical/Chemical treatment

Since the above processes are non-destructive, they must be matched with satisfactory disposal techniques.

1. Steam Sterilization

This process uses saturated steam in a pressure vessel or autoclave operated in either of two general ways. Under "gravity displacement," air is forced out of the chamber and replaced by steam while the "pre-vacuum" type removes air before steam injection. Typically the former process operates at 121°C at a pressure between 117-124 kPa and the latter at 132°C under 186-220 kPa, with a cycle time preset appropriate to the microorganisms being destroyed.

Decontamination is achieved primarily through steam penetration and standardized operating practice is essential to promote effective sterilization. In particular, low density wastes such as plastics, are the most amenable to this treatment and small loads help ensure uniform temperatures being maintained. Containers for the waste must permit good steam circulation and if plastic bags are used, they should preferrably be heat-resistant and placed inside a second rigid container to avoid spillage.

In addition to dense wastes, such as large body parts, autoclaving is not suitable for multiple hazard materials including radioactives, antineoplastics and toxic or volatile chemicals. The efficiency of the treatment is monitored regularly using biological indicators with Bacillus stearothermophilus being most often recommended.

### Mobile Autoclave

A Texas company has built a prototype 45 foot long autoclave that is mounted on a semi-trailer and can be moved from hospital to hospital, sterilizing about 682 kilograms (1500 pounds) of waste per hour. Two operators plus a technician are needed to run the system.

Before the mobile autoclave comes to a hospital, infectious wastes are stored on-site in plastic containers similar to those used for curbside pickup. On autoclave day, the containers are moved to the hospital loading dock where they are dumped into large, stainless-steel autoclave baskets that hold 227 kilograms (500 pounds) of red bags and sharps containers. The autoclave holds three baskets or 682 kilograms (1500 pounds) of materials. The autoclave system is designed such that it can autoclave regular plastic bags rather than require wastes be placed in plastic autoclave bags. The autoclave uses dry steam at 135° celcius for the treatment of biomedical wastes. Technicians monitor the residence time and temperature to make sure waste materials are properly sterilized. When the process ends and the wastes have cooled, the sterilized wastes are dumped into a compactor-trailer.

The system offers great flexibility; one week the unit might move from hospital to hospital and another it might be positioned at a landfill site to receive and treat loads collected from small hospitals by route trucks (Infectious Waste News, 1987).

### 2. Dry Heat Sterilization

Treatment methods using heat transfer are usually applied to large volumes of liquid or solid infectious wastes. Liquids are heated in either a batch or continuous mode to maintain sterilizing temperatures for a set time and often require cooling to meet prevailing discharge requirements. Similar precautions as taken with steam sterilization are necessary to ensure efficient treatment. Mixing may be added for uniform heat transfer. Solids are heated in ovens (usually electrically powered) and temperatures of 320-338°F are typically maintained for 2-4 hours. The extensive time and energy requirements often preclude common use of dry heat inactivation of solid wastes. Spores of Bacillus subtilis (niger globigii) are often recommended as the monitoring indicator.

### 3. Gas/Vapour Sterilization

Similar in application to autoclaving, these processes commonly employ ethylene oxide or formaldehyde as the sterilant instead of steam. Substantial evidence exists that both chemicals are probably human carcinogens and caution is therefore exercised with their use. Both are absorbed by porous materials causing potential for continued release of the gases long after treatment, if not properly aerated.

Ethylene oxide penetrates polyethylene, paper and muslin and is primarily used to sterilize thermolabile supplies for reuse. The Canadian Standards Association has issued a General Instruction dated July 1984 for the ethylene oxide process in hospitals (CSA, 1984). It is not a recommended sterilization method for wastes. Formaldehyde is used to sterilize certain disposable items, such as HEPA filters, but it is viewed to be a specialized process not appropriate for general use. The recommended monitoring indicators for both gases are the same as for dry heat sterilization.

### 4. Irradiation

A number of technologies are emerging for sterilizing biomedical wastes, ranging from the use of electro-magnetic radiation through ultraviolet, microwave and gamma ray applications.

Ultraviolet radiation is limited to surface treatment, penetrating only a few centimetres, and consequently is of little value in the sterilization of wastes. High electrical energy and shielding are required.

Microwave sterilization is currently the subject of study in Quebec and one specific reference on its approved use appears in the procedures for Arkansas State relative to contaminated laboratory cultures as an option to incineration or autoclaving.

Ionizing radiation by gamma rays is usually produced from the cobalt-60 isotope. Gamma rays can penetrate to a depth of several metres and thus have potential use in waste sterilization. Its advantages include the capability to treat all kinds of wastes with nominal power requirements and no residual heat. Its feasibility is questionable because of the high capital cost, space requirement and specialized operation. Ultimate disposal of the decayed radiation source is also problematical. The monitoring indicator recommended by approving jurisdictions is Bacillus pumilus spores.

5. Physical/Chemical Treatment

A variety of preparations can be accommodated within this category including neutralizing solidification, distillation, compacting, dilution, disinfection and grinding. With the exception of waste chemicals and pharmaceuticals, the processes most applicable to the general waste stream are the chemical disinfection and grinding options.

Chemical disinfection provides a means of destroying microorganisms but not necessarily bacterial spores and viruses. It has common usage in the cleansing of equipment and surfaces and also in the treatment of liquid wastes.

The chemicals used are generally acids, bases, aldehydes, alcohols, amines, halogens, heavy metal salts, ketones, quaternary ammonium salts, phenolics and hydrogen peroxide. For liquid disinfection, sodium hypochlorite and formaldehyde are common. To be effective, the disinfectant, its concentration and time of contact must be matched with the type of organism, level of contamination, proteinaceous matter present, pH, temperature and other physical parameters.

The combination of chemical disinfection and hammermill pulverization is a process currently being tested and marketed (Medical Post, 1988; Medical Safetec, 1987). The hammermill reported can accept almost all waste material reducing it to fine particles which are then contacted by a concentrated sodium hypochlorite solution. The solids are separated by settling in a weir tank and the carrier fluids normally discharged to sewer. Test results from one such proprietary system have indicated the destruction of vegetative micro-organisms within 5 minutes and all spore forming bacteria after 2 hours exposure to a hypochlorite solution containing 2000 ppm (0.2%) free available chlorine. The system is maintained at negative pressure to control aerosols and the discharged air, after passage through a HEPA filter, was reported to be sterile.

It should be noted that some of the above processes can be applied to facilitate reuse of materials and hence reduce the volume of wastes requiring disposal. Other options are available to reduce disposal needs. For example, good management of chemical and drug supplies can avoid wastage. Some opportunities for recycling of sterilized plastics, rubber and metal have been identified under European studies and the reuse of sterilized toluene has been established as being feasible.

# APPENDIX 6.4

## 6.4 CENTRAL DISPOSAL FACILITIES IN OTHER JURISDICTIONS

### 6.4.1 Ontario

As a result of the closure of Toronto Metro Works landfills, refuse transfer stations and incinerators to several Toronto hospitals, as well as the requirement of licenced incinerators for burning biomedical wastes and the unacceptability of hospital incinerators to meet new guidelines, the Hospital Council of Metropolitan Toronto (HCMT) established a Task Force to study the feasibility of establishing a central facility for managing biomedical wastes from the Greater Metro Toronto area (Task Force of the Hospital Council of Metropolitan Toronto and McLaren Engineers Inc., 1986). Management options reviewed were:

- status quo
- incineration
- shredding/disinfection
- autoclaving
- combination

A more comprehensive discussion of the HCMT Task Force report is provided in Appendix A10.5.

### 6.4.2 California

Security Environmental Systems, a California based company has been in the biomedical waste disposal business since 1972 and currently services 600-700 health care facilities within a 150 mile radius of the Los Angeles area. The company operates two central facilities in Los Angeles, one equipped with several industrial autoclaves for the sterilization of biomedical wastes and the other equipped with an incinerator, that was reported to be the only hospital waste disposal incinerator under permit in Southern California. Biomedical wastes are packaged for transport at the health care facility and transported to either of the two Security Environmental Systems facilities for sterilization prior to landfill disposal or for disposal by incineration depending upon the particular category of biomedical waste (B.C. Task Force on Biomedical Waste Management, April, 1988).

# APPENDIX 6.5

## 6.5 REFERENCES

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# APPENDIX 7.0

## LEGISLATIVE AND REGULATORY BIOMEDICAL WASTE CONTROLS

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# INTRODUCTION

The objective of this legislative review is to assess the current management strategies required by law in other jurisdictions.

Prior to the first meeting of the Task Force, the Ministry of Environment mailed out written requests for existing or pending legislation for biomedical wastes to the nine other Canadian Provinces and all fifty American States. Written responses were received from four Provinces, thirty-three American States and two U.S. Counties.

A review of existing Federal legislation for the U.S. and Canada was conducted through a review of the available literature and correspondence with Federal agencies. To assess controls for biomedical waste management in European countries, a review of available literature was also conducted.

The review of legislation focussed on the following legislative requirements:

- Existence of legislation
- Administration of legislation
- Review of definitions of biomedical wastes
- Applicability of legislation
- Management requirements under the legislation for handling, packaging, storing, transporting, treating and disposing of biomedical wastes.

# APPENDIX 7.1

## 7.1 CANADIAN INITIATIVES

### 7.1.1 Federal Legislation

1. Animal Disease and Protection Act (Canada, unknown a)

Under the Animal Disease and Protection Act, which administered by Agriculture Canada, communicable disease is defined as any disease which is infectious or contagious.

These regulations give a veterinary inspector the power to order persons having possession, care or custody of an animal that dies and is suspected of having died of a communicable disease or is destroyed because of infection by such disease, to dispose of the carcass in such a manner as the veterinary inspector specifies.

No provisions are given as to the manner of disposal of contaminated carcasses required.

2. Fisheries Act (Canada, unknown b)

Subsection 33(2) of the Fisheries Act, administered by Fisheries and Oceans Canada, prohibits the disposal of deleterious substances into fishing waters except as may be permitted by the regulations. This Act applies to those waters frequented by fish or waters leading to such.

3. Transportation of Dangerous Goods Act (Canada, 1980)

Under the Transportation of Dangerous Goods Act and Regulations, administered by Transport Canada, poisonous (toxic) and infectious substances are regulated as dangerous goods (Class 6.2). Infectious agents included under these Regulations are listed in Schedule VII of the Federal Transportation of Dangerous Goods Act, a copy of which is given in Figure A7.1.

For the purpose of these Regulations, infectious substances are divided into three groups as follows:

Group IA - the most dangerous infectious substances, and including those infectious substances listed in Table I of Schedule VII and other infectious substances having similar virulance and risk.

Group IB - dangerous infectious substances, less dangerous than those listed in IA and including those infectious substances listed in Table II of Schedule VII.

Group IC - dangerous infectious substances, less dangerous than those listed in Tables I and II of Schedule VII and including those infectious substances not included in IA and IB but that pose a significant risk to the individual or community.

# FIGURE A7.1 TRANSPORTATION OF DANGEROUS GOODS REGULATIONS SCHEDULE VII - INFECTIOUS SUBSTANCES

## SCHEDULE VII

## INFECTIOUS SUBSTANCES

1 For the purpose of these Regulations, infectious substances are divided into three groups as follows

*(a)* Group IA, are the most dangerous infectious substances and includes

(i) the Infectious Substances listed in Table I to this Schedule, and

(ii) any other infectious substances that

(A) have a degree of virulence similar to that of any substance listed in that Table,

(B) pose a risk to the community similar to the risk posed by any substance listed in that Table,

(C) are resistant to available treatment or for which no treatment is available, or

(D) are diagnostic specimens that are likely to contain any of the substances listed in that Table.

*(b)* Group IB, are dangerous infectious substances less dangerous than the infectious substances included in Group IA and includes

(i) the Infectious Substances listed in Table II to this Schedule, and

(ii) any other infectious substances that

(A) have a degree of virulence similar to that of any substance listed in that Table,

(B) pose a risk to the community similar to the risk posed by any substance listed in that Table,

(C) are resistant to available treatment or for which no treatment is available, or

(D) are diagnostic specimens that are likely to contain any of the substances listed in that Table.

*(c)* Group IC, are dangerous infectious substances that are less dangerous than the infectious substances in Group IB and includes

(i) infectious substances that are not included in Group IA and Group IB but that pose a significant risk to the individual or the community, and

(ii) any diagnostic specimens that are likely to contain any of the substances referred to in subparagraph (i)

### TABLE I

*Infectious Substances, Human*

Ebola virus

Hemorrhagic fever agents, including Crimean hemorrhagic fever (Congo), Junin, Machupo, Bolivian and Korean hemorrhagic fever viruses

Herpesvirus simiae (B virus)

Lassa virus

Marburg virus

Rift Valley Fever virus

Tick-borne encephalitis virus complex, including Russian spring-summer encephalitis, Kyasanur forest disease, Omsk hemorrhagic fever and Central European encephalitis viruses

Whitepox viruses

Variola major or minor

*Infectious Substances, Animal*

African swine fever virus
Borna disease virus
Foot and mouth disease virus
Fowl plague virus
Goat pox virus
Hog cholera virus
Lumpy skin disease virus
Mycoplasma mycoides subspecies mycoides pathovar bovis
Newcastle disease virus

Pasteurella multocida type B

Peste des petits ruminants virus

Pseudorabies virus

Rinderpest virus

Sheep pox virus

Swine vesicular disease virus

Teschen disease virus

Vesicular exanthema virus

Vesicular stomatitis virus

### TABLE II

*Infectious Substances, Human*

Actinobacillus mallei

Arborvirus, all species

Bacillus anthracis

Bartonella, all species

Brucella abortus

Brucella melitensis

Chlamydia psittaci

Coccidioides immitis

Coxiella burnetii

Francisella tularensis

Histoplasma capsulatum

Lymphocytic choriomeningitis virus (LCM)

Mycobacterium bovis

Mycobacterium tuberculosis

Rabies virus

Rickettsia, all species

Yersinia pestis

Hybrid or mutant organisms developed during laboratory procedures, including DNA (deoxyribonucleic acid) recombinations, that require physical containment level D or higher by the Guidelines produced by the Medical Research Council of Canada entitled "Directives for the handling of recombinant DNA and animal viruses and cells"

Oncogenic viruses that require physical containment level D or higher by the Guidelines of the Medical Research Council of Canada

(Canada, 1980)

The shipment of such wastes in quantities greater than or equal to 5 kg or 5 L must be accompanied by a manifest. No consignor may offer an infectious substance included in Division 2 of Class 6 to a carrier for transport unless:

a) he has received notification from the consignee that receipt of the goods is not prohibited by any applicable law at the destination point or in any country through which the goods may transit.

b) he notifies the consignee of:

    i) the date of shipment and expected arrival
    ii) the identification of the means of transport to be used
    iii) the shipping document identification number.

A shipping document must be used, and it must indicate the type of infectious substance being shipped:

a) where the infectious substance is a diagnostic specimen, the word "Diagnostic Specimen"; and
b) where the infectious substance is not a diagnostic specimen, the name of the micro-organism.

Before the dangerous goods are transported, the consignor shall label all containers and every package containing the dangerous goods with the appropriate designated label given in Part I of Schedule V (Figure A7.2).

In response to concerns raised by the Federal Ministers of National Health and Welfare, Transport and the Environment on January 18, 1988, it has been proposed that Health Care Wastes be included into the Transportation of Dangerous Goods Regulations.

Amendments to the Federal Transportation of Dangerous Goods Act and Regulations have been proposed that would see human body parts, tissues, blood, body fluids or materials thus contaminated, regulated as a Class 9.3 waste.

### 7.1.2 Provincial Legislation

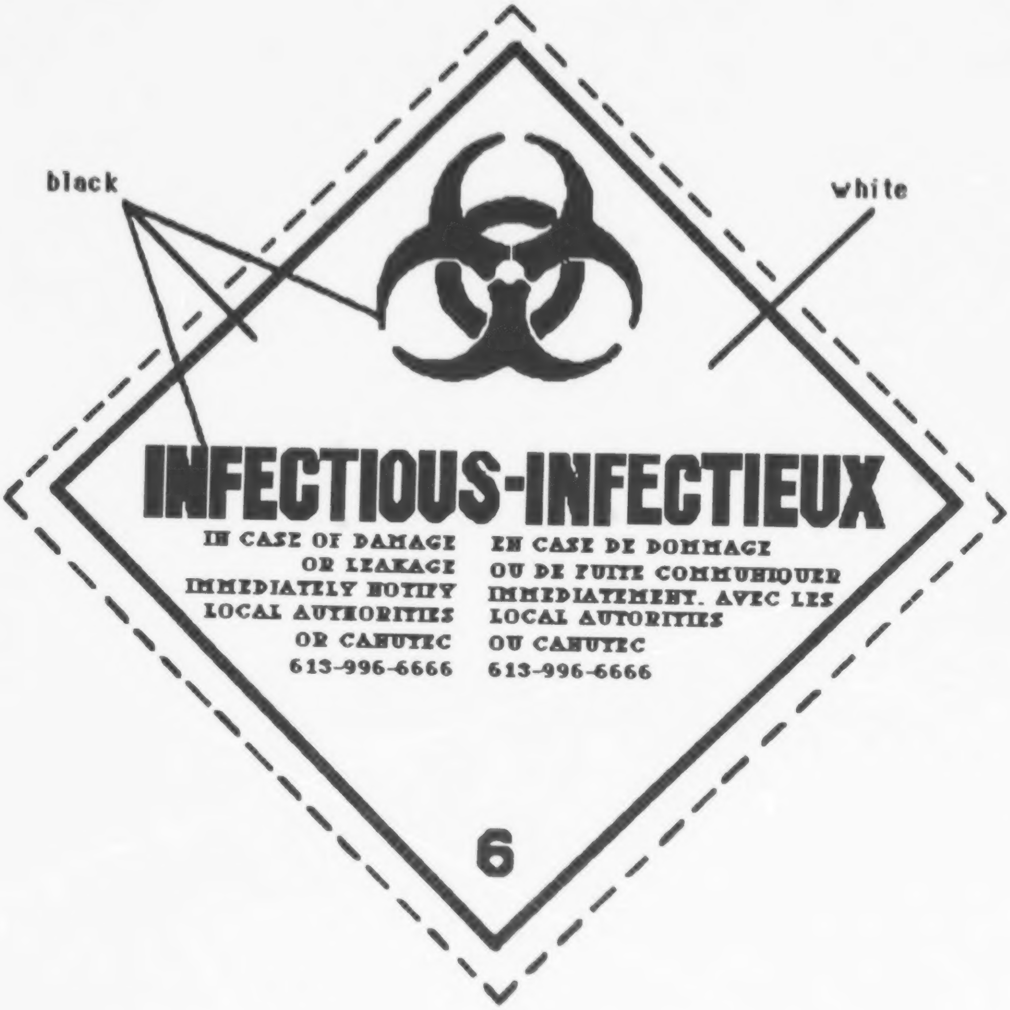
1. Newfoundland and Labrador

    There is at present no legislation for the management of biomedical wastes. The Department of Environment has the authority under the Waste Disposal Act to require hospitals to colour-code bags of various waste classifications; however, the use of such practices is at present voluntary.

    Most hospitals in the Province meet disposal requirements by the use of pathological incinerators certified in accordance with the Province's Waste Material (Disposal) Act, 1973. Older hospital incinerators are considered by the Department of Environment to be adequate for waste treatment.

    Some pharmaceuticals and innocuous waste chemicals are co-disposed of at municipal landfills or incinerators under the supervision of Department of Environment staff and the municipalities involved.

FIGURE A7.2 TRANSPORTATION OF DANGEROUS GOODS REGULATIONS
SCHEDULE V-PARTI, CLASS 6, DIVISION 2.
INFECTIOUS SUBSTANCE LABEL


black
white
INFECTIOUS-INFECTIEUX
IN CASE OF DAMAGE
OR LEAKAGE
IMMEDIATELY NOTIFY
LOCAL AUTHORITIES
OR CANUTEC
613-996-6666
EN CASE DE DOMMAGE
OU DE FUITE COMMUNIQUER
IMMEDIATEMENT. AVEC LES
LOCAL AUTORITIES
OU CANUTEC
613-996-6666
6

(Canada, 1980)

Carcasses are not considered as part of the biomedical waste stream (Strong, 1988).

## 2. New Brunswick

There is at present no specific legislation dealing with the management of biomedical wastes (New Brunswick, unknown).

## 3. Quebec

Under Article 6.(10) "pathological wastes" are excluded from the Hazardous Waste Regulations of the Ministry of the Environment's Environmental Quality Act. In the next amended version of the regulations, biomedical wastes will again be excluded, but will be defined.

Provincial solid waste regulations permit non-contaminated biomedical wastes, excluding human anatomical wastes, to be disposed of in a sanitary landfill.

Both the Ministry of the Environment and the Ministry of Health and Social Services are working on policies for the separation, handling, labelling, storage and pretreatment of biomedical wastes. Both policies are scheduled for release in 1988 (Anctil, 1987).

## 4. Ontario

### a) Ministry of Health

All hospitals, other human health care facilities and medical laboratories, are licensed by the Ministry of Health. Facilities are periodically inspected by Ministry staff to ensure that adequate medical standards are maintained. Under the Health Protection and Promotion Act and Regulations, Ministry personnel administer the handling and disposal of biomedical wastes at medical facilities (Ontario, unknown a).

### b) Ministry of Labour

The Ministry of Labour administers the Occupational Health and Safety Act and Regulations in relation to workers operating, maintaining or repairing biomedical waste management facilities. Ministry staff advise, educate or train (as appropriate) all parties with respect to rights, duties and responsibilities under the legislation (Ontario, unknown b).

### c) Ministry of the Environment

Under the Ministry of Environment's Environmental Protection Act, Regulation 309, "pathological wastes" as defined are regulated as a hazardous waste under Schedule 3. Generators of such waste are not subject to any small quantity exemption.

Pathological waste is defined as:

i) any part of the human body, including tissue and bodily fluid, but excluding fluids, extracted teeth, hair, nail clippings and the like, that are not infectious;

ii) any part of the carcass of an animal infected with a communicable disease or suspected by a licensed veterinary practitioner to be infected with a communicable disease; or

iii) non-anatomical waste infected with communicable disease.

## On-site Handling and Disposal

At present the on-site handling and disposal of biomedical wastes in hospitals, related health care facilities and laboratories generating such wastes is the responsibility of facility administration.

Regulation 309 has exempted all existing hospital incinerators from the operation of Section 27 of the Environmental Protection Act with respect to their establishment, use and operation. As such, hospital incinerators previously operating without a valid Certificate of Approval have been legalized. Further, Regulation 309 permits neighbouring medical facilities to share hospital incinerators and/or autoclaves without resorting to public hearings.

## Off-site Handling and Disposal

1. Generators of pathological waste are required under Regulation 309, to be registered with the Ministry of the Environment and the use of Ontario manifests for hazardous wastes required for all transactions involving such wastes whether originating or terminating in Ontario.

2. Persons involved in the transportation of pathological waste are operating a waste management system and as such must be in possession of a valid Waste Management Systems Certificate of Approval issued by the Ministry of the Environment.

3. Licensed biomedical waste haulers shall not accept untreated pathological waste for transport to an Ontario registered disposal site, unless wastes are properly identified, packaged, colour coded, the rigid outer containers colour coded and labelled with the approved biohazard logo and the description of contents manifested in compliance with Ontario manifest requirements and conforming to the Federal Transportation of Dangerous Goods Act and Regulations (Ontario, 1985).

The Ministry of the Environment has published a guide entitled "Guidelines for the Handling and Disposal of Biomedical Wastes from Health Care Facilities and Laboratories" amended 1986.

## 5. Manitoba

Infectious wastes are classified as dangerous goods, Class 6.2 under the Provincial Dangerous Goods Handling and Transportation Act, administered by the Department of Environment and Workplace Safety and Health. As such, generators are required to handle and package infectious waste in compliance with these regulations and all shipments of these wastes must be manifested. There is no exemption for small quantity generators, with all quantities of such wastes being required reportable under the Act. Transportation of infectious wastes may only be carried out by transporters licenced to handle dangerous goods.

The Department of Environment and Workplace Safety and Health has proposed amendments to Provincial Regulation 208/76 respecting waste disposal grounds, that would limit the use of waste disposal grounds by hospitals (Manitoba, 1984).

## 6. Alberta

### a) Environment

No response to the letter requesting legislation for biomedical waste management was received from the Province of Alberta. However, for the purpose of hazardous waste management, the Alberta Department of the Environment has adopted the Transportation of Dangerous Goods Act (Canada). As such, infectious wastes as defined under the Federal Act are included in the Hazardous Chemicals Act and Regulations of Alberta as a Class 6 Hazardous Waste, and must be managed in accordance with criteria adopted by the Province from the Federal Transportation of Dangerous Goods Act. Generators of less than 5 kilograms or 5 litres per month are exempted from legislational requirements (Alberta, 1985a).

### b) Community and Occupational Health

In accordance with the Alberta Public Health Act, Bodies of Deceased Persons Regulations, a funeral director or other persons taking charge of the body of a person who died or is suspected or having died with a specified communicable disease, must notify the local medical health officer within 12 hours. The regulations identify eleven specified communicable diseases including Acquired Immune Deficiency Syndrom (AIDS).

A person who removes the body of a person infected with a specified communicable disease shall ensure that all body orifices are blocked with absorbent cotton and that the body is enclosed in a metal coffin liner or wrapped in a sheet saturated with formilin, mercury chloride, carbolic acid or other disinfected solution of equivalent strength. The body of a person who died with a specific communicable disease must not be embalmed.

When the body of a person infected is to be transported, the person in charge of the body pursuant to the disinterment shall ensure that a label reading "Danger - This Body is Infected with a Specified Communicable Disease" is attached to the metal coffin liner.

The funeral director or other person in charge of the interment, cremation or other disposition of the body shall ensure that the body is enclosed and sealed in a metal coffin liner prior to any funeral service or interment and that no person is unnecessarily exposed to the body (Alberta, 1985b).

7. British Columbia

a) Ministry of Environment

B.C. Special Waste Regulations, enacted April 1, 1988, under the Waste Management Act include infectious wastes as "dangerous goods" as defined in Section 2 of the Transportation of Dangerous Goods Act (Canada) and as regulated in the Federal Regulation. So defined as a dangerous good, infectious wastes are therefore included in the definition of special waste under the B.C. Special Waste Regulation.

Under these regulations generators of more than 100 kg or 100 L of infectious waste in a 30-day period must register with Waste Management as a Special Waste generator. A special waste facility in operation prior to April 1, 1988 does not require separate authorization to continue to handle special wastes until January 1, 1990; however, generator registration is still required for those facilities generating more than 100 kg or 100 L of infectious waste in a 30-day period.

A manifest is required for shipments of special waste consignments in excess of 5 kg or 5 L of each special waste. These limits are in accordance with manifest requirements under the TDG Regulations. A manifest is not required for special waste shipments transported solely within the boundaries of the property owned, leased or controlled by the person who produces or stores the special wastes.

Generators of special waste are responsible to ensure that persons transporting special waste have a B.C. Licence to Transport Special Waste and that such waste is transported to a storage or disposal facility that is under permit or is authorized to handle special waste.

Section 50 of the Special Waste Regulation specifies the general requirements for special waste containers. The regulations require the use of containers which will not release special waste to the environment under normal conditions of storage or transport. Special waste containers must also be compatible with their contents to preclude unfavourable emissions or chemical reactions that might reduce the effectiveness of packaging. TDG Regulations currently do not have any requirements for containers (British Columbia, 1988).

b) Ministry of Health

Under Chapter 161, provisions and amendments to the Provincial Health Act,a medical health officer has the power to adopt, for the disinfection and disposal of excreta and for the destruction and disinfection of utensils, bedding, clothing and other items that have been exposed to infection. Such articles may be directed to be destroyed of under proper authority (British Columbia, 1979).

Under Part 4, the Handling of Dead Bodies of the Provincial Health Act's Communicable Disease Regulations, a funeral director or other person requested to handle the body of a person who died from anthrax, plague or viral hemorrhagic fever, shall immediately notify the medical health officer. The funeral director or other person so requested, shall wrap and securely seal the body in heavy plastic sheeting before removing it from the room where death occurred, place it wrapped and sealed in a casket, immediately close the casket and not permit the casket to be reopened.

No person shall accept a dead body for removal or transport unless:

i ) it will reach its destination within 72 hours from the time of death
ii ) it is embalmed
iii ) it is placed in a metal lined casket which is permanently sealed to prevent leakage or reopening; and enclosed by a strong outside box.

No person shall ship a dead body by rail, air, ship or truck without a valid transit certificate. A properly completed burial permit issued under the Vital Statistics Act attached to the head of the box containing the casket constitutes a valid transit certificate (British Columbia, 1983).

c) Ministry of Labour and Consumer Services

Under the Cremation Act, Chapter 81, crematoria established in the Province after February 20, 1913 must be inspected and certified to the Minister of Labour and Consumer Services by the chief engineer of the Ministry of Transportation and Highways to be:

i ) complete and built in accordance with the plans on the site approved; and
ii ) properly equipped for the disposal of human remains by burning.

Municipal councils and cemetary companies formed under the Cemetary Company Act are empowered to provide and maintain burial grounds or cemetaries, or anything essential, ancillary or incidental to them, extending to and including provision and maintenance of crematoria (British Columbia, 1979).

d) Workers' Compensation Board of British Columbia

In accordance with Section 76 of the Workers' Compensation Board Industrial Health and Safety Regulations, biologicals and infectious waste material shall be collected in separate, tightly covered containers and disposed of in a manner which will prevent injury or disease to workers and which is acceptable to the Board (Workers' Compensation Board of British Columbia, 1980).

### 7.1.3 MUNICIPAL

1. City of Vancouver

In addition to regulations regarding discharges to landfill, the City of Vancouver regulates discharges to sewer. Persons administering the Sewer Use By-law No. 5320 interpret the following section to include infectious wastes, but no attempt has been made to check medical facilities for compliance.

Section 2 - Waste Discharges

Subsection 2.1 - Prohibited Discharges

Section 2.1.1 prohibits the discharge to the sewer of
(c) any corrosive, noxious or malodorous gas, liquid, or substance which either singly or by interaction with other wastes, is capable of
  (i) creating a public nuisance or hazard to life;
  (ii) preventing entry into a sewer or pump station; or
  (iii) causing damage to the sewer system
(f) any solid or viscous substance capable of obstructing wastewater flow or interfering with the operation of the sewerage system or treatment facilities, including but not limited to the substances set out in Table 1.

TABLE 1

Substances specifically prohibited in wastewater discharge:

| | |
|---|---|
| SOLID MATERIAL | Ashes, cinders, sand, mud, straw, grass clippings, insoluble shavings, metal, glass, rags, offal, shells of shellfish, hair and flashings from operators such as hide processing, spent grain and hops, whole or ground paper or plastic food or beverage containers. |
| VISCOUS MATERIAL | Tar, asphalt, lard, tallow, baking dough, chemical residues, cannery waste bulk solids, blood, paint residues, slurries of concrete, cement, lime or mortar. |

Subsection 2.2 - Standards for Waste Discharges

Section 2.2.1 (1) No person shall discharge or permit to be discharged into a sanitary sewer or combined sewer any waste that has any of the following characteristids:

(e) any water or waste having a suspended solids content of more than 600 milligrams per litre;
(g) any water or waste that will by itself or with other water or wastes in the sewerage system, release noxious gases, or form suspended solids in excess of 600 milligrams per litre or create any other condition deleterious to structures or treatment processes;

## 2. Greater Vancouver Regional District

Since December of 1986, the following regulations have been applied at all waste disposal facilities operated by the GVRD and the District of Surrey, including transfer stations, resource recovery plants, incinerators, and landfills:

Biomedical wastes which are infectious or otherwise hazardous are not permitted, including: hypodermic needles intact and other sharps, body fluids and body parts of any kind, including tubing and receptacles in which the aforesaid have been contained, all materials from pathology, solvents, drugs, and other pharmaceuticals. Where infectious wastes or hazardous wastes are discovered in the municipal waste system, the offending generator is asked to remove the same. Additional costs incurred by the disposal facility are charged to the offending generator.

There are no specific requirements for biomedical wastes that are not infectious or hazardous as defined above (GVRD, 1988).

## 3. Municipality of Metropolitan Toronto

Since October 1985, the Department of Works, Refuse Disposal Division, for Metropolitan Toronto has prohibited the disposal of pathological wastes, as defined in Ontario Regulation 309 at landfills.

All hospital wastes arriving at landfills must be declared to the weighmaster as originating from a medical facility and be accompanied by a certificate stating that the load does not contain pathological wastes.

Hospital wastes shall be packed as follows:

i ) All other waste shall be enclosed in double plastic bags of 3 mil thickness. Plastic bags shall be black and opaque.

ii ) Sharps shall be enclosed in hardshell containers before being placed in the double plastic bags (Toronto, unknown).

# APPENDIX 7.2

## 7.2 AMERICAN INITIATIVES

### 7.2.1 Federal Regulations

In October, 1987, two separate Bills amending the Solid Waste Disposal Act, administered by the EPA, to address the issue of infectious wastes, were introduced to the US Senate and the House of Representatives.

Bill HR3467 — Amending Subtitle G of the Solid Waste Disposal Act to address the study of infectious and pathological wastes. Under this Bill the USEPA has twelve months to conduct a study on whether there is a necessity to regulate under Subtitle C of this Act, the generation, transport, treatment, storage and disposal of pathological or infectious wastes (United States of America, 1987a).

Bill HR3478 — Amending the Marine Protection, Research and Sanctuaries Act and the Federal Water Pollution Control Act to prohibit the dumping of medical waste in ocean and navigable waters and amending the definition of medical waste to include waste from health care facilities and veterinary facilities (United States of America, 1987b).

The Bill also amends the Solid Waste Disposal Act requiring the USEPA to promulgate regulations for infectious wastes, including wastes from health care and veterinary facilities, to address the generation, transportation, treatment, storage and disposal of these wastes. The amendment establishes the authority for the EPA to inspect facilities handling or having handled infectious wastes and to obtain samples from these facilities for the purpose of enforcement.

In October, 1988, the U.S. Senate and House of Representatives approved Bill HR3515, the "Medical Waste Tracking Act of 1988," to take effect on January 25, 1988.

Bill HR3515 - Amending the Solid Waste Disposal Act, requiring the US EPA to establish a demonstration program for tracking medical wastes in New York, New Jersey and Connecticut. Under this Bill, a manifest program would be required to be in operation not later than 6 months after the enactment of this Bill. In addition, facilities generating medical waste, as defined by the US EPA's Guide for Infectious Waste Management," would be required to:

- segregate wastes at the point of origin where applicable;
- place wastes in a container that will protect waste handlers and the public from exposure; and
- appropriately label containers of the wastes.

The Administration may establish an exemption for small quantity generators who generate less than 22.7 kilograms (50 pounds) per month (United States of America, 1988).

## 7.2.2 State Regulations

### 7.2.2.1 National Solid Waste Management Association Survey

Status of State Regulations

Thirty-two US states were identified as having some form of regulations for the management of infectious waste and four states have issued guidelines for the management of these wastes. Of the states with regulations, thirteen anticipate changes to their regulations and three of the four states with guidelines anticipate that regulations will be issued in the near future.

Seven states regulate infectious waste as a "hazardous waste," while fourteen states have no regulations or guidelines for infectious wastes at the present; however, six of these states anticipate regulations within the year.

Where infectious waste regulations do exist, administration of these regulations is split almost evenly between agencies for Health and agencies for the Environment with some incidences of joint administration of the regulations.

Definitions of Infectious Wastes

Of thirty-two states with regulations for infectious wastes, twenty-eight states have legal definitions of infectious waste and one state with guidelines also specifies infectious waste streams. The most frequently cited definitions for infectious wastes are reflective of those from the USEPA Guide, the Centers for Disease Control and the Joint Commission for Accreditation of Hospitals.

Sources of Infectious Wastes

Infectious waste regulations and guides are primarily aimed at regulating infectious wastes coming from hospitals; however, many states do recognize that other health care and related facilities also generate the same types of wastes. Sixteen states with regulations and three states with guides, subject other waste generators to the same requirements as hospitals.

Treatment and Disposal

Incineration and autoclaving are the most commonly accepted treatment methods for infectious wastes. Eighteen states with regulations allow other methods of treatment including but not restricted to, chemical disinfection and irradiation.

Twenty states with regulations require infectious waste to be treated and rendered non-infectious prior to wastes being landfilled. Four other states have the same requirements, but do not define which waste streams are infectious.

Three states require only waste segregation and labelling of infectious waste prior to allowing waste to be landfilled, while five states with regulations and three states with guidelines prohibit the disposal of any infectious waste at landfills.

Only four states with regulations require all infectious wastes generated to be treated and rendered non-infectious at the site of generation.

FIGURE A7.3 NSWMA INFECTIOUS WASTE SURVEY, OCTOBER, 1987

| | AL | AK | AZ | AR | CA | CO | CT | DE | DC | FL | GA[1] | HI | ID | IL | IN | IA | KS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ▶ Does your state regulate infectious wastes in some way? | Y | N | Y | Y | Y | Y | N | N | N | Y | N | Y | Y | Y | Y | Y | Y |
| ▶ Does your state have a legal definition of what constitutes an infectious waste stream? | N | N | Y | Y | Y | N | N | N | N | Y | N | Y | Y | Y | Y | N | Y |
| ▶ Which of the following treatments does your state REQuire or RECommend prior to landfilling? | | | | | | | | | | | | | | | | | |
| Autoclaving | | | | | | | | | | | | | | | | | REQ |
| Incineration | | | | | | | | | | | | | | | | | REC |
| Either | REQ | REC | REQ | REQ | REQ | REQ | REC | REC | REC | REQ | REC | REQ | REQ | REQ | REQ | REQ | |
| ▶ Does your state regulate infectious waste as a hazardous waste? | N | N | N | Y | Y | N | N | N | N | N | N | N | N | Y | Y | N | N |
| ▶ Does your state impose hospital infectious waste regulations on other generators? | N | N | Y | N | Y | N | N | N | N | N | N | N | N | N | N | Y | Y |
| ▶ Does your state regulate the transportation of untreated infectious wastes? | N | N | Y | N | Y | N | N | N | N | N | N | N | N | N | Y | N | N |
| ▶ Is your state expecting infectious waste legislation or regulations in the next year? | N | N | N | N | N[2] | N | Y | Y | Y | Y | N | N | Y | N | Y | N | N |

[1] Only the GA Department of Human Resources responded to the survey. The Department of Natural Resources chose not to respond.

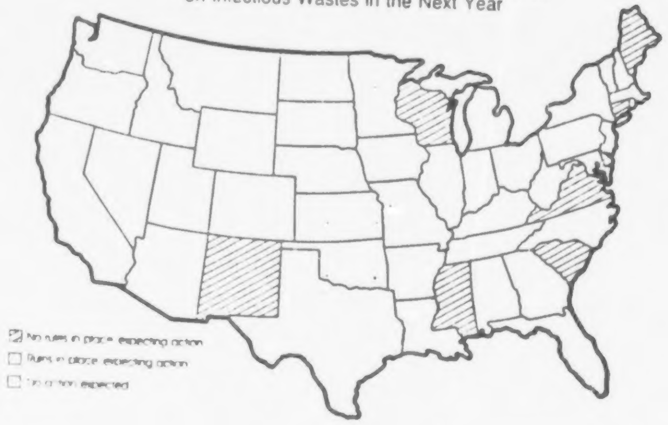
[2] Neither incineration nor autoclaving are required except for infectious body parts and viable cultures. All other infectious wastes may go to a sanitary landfill.

| | KY | LA | ME | MD | MA | MI | MN | MS | MO | MT | NE | NV | NH | NJ | NM | NY | NC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ▶ Does your state regulate infectious wastes in some way? | Y | Y | N | Y | Y | N | Y | N | Y | N | Y | Y | Y | Y | N | Y | Y |
| ▶ Does your state have a legal definition of what constitutes an infectious waste stream? | Y | Y | N | Y | Y | N | Y | N | Y | N | Y | Y | Y | Y | N | Y | Y |
| ▶ Which of the following treatments does your state REQuire or RECommend prior to landfilling? | | | | | | | | | | | | | | | | | |
| Autoclaving | | | | | | | | | | | | | | | | | |
| Incineration | | | | | | | | | | | | | | | | | |
| Either | REQ | REC | REC | REQ | REQ | REC | REQ | REC | REQ | REC | REQ | REC | REQ | REQ | REC | REQ | REQ |
| ▶ Does your state regulate infectious waste as a hazardous waste? | N | N | N | N | N | N | N | N | Y | N | N | N | N | N | N | N | N |
| ▶ Does your state impose hospital infectious waste regulations on other generators? | Y | N | N | Y | Y | N | Y | N | Y | N | N | N | Y | Y | N | N | Y |
| ▶ Does your state regulate the transportation of untreated infectious wastes? | N | N | N | Y | Y | Y | Y | N | Y | N | N | N | Y | N | N | Y | N |
| ▶ Is your state expecting infectious waste legislation or regulations in the next year? | N | Y | Y | Y | N | N | Y | Y | Y | N | Y | N | N | Y | Y | Y | N |

| | ND | OH | OK | OR | PA | RI | SC | SD | TN | TX | UT | VT | VA | WA | WV | WI | WY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ▶ Does your state regulate infectious wastes in some way? | Y | N | N | Y | Y | Y | N | N | Y | Y | N | Y | N | N | Y | N | N |
| ▶ Does your state have a legal definition of what constitutes an infectious waste stream? | Y | N | N | N | Y | Y | N | N | Y | Y | N | Y | N | N | Y | N | N |
| ▶ Which of the following treatments does your state REQuire or RECommend prior to landfilling? | | | | | | | | | | | | | | | | | |
| Autoclaving | | | | | | | | | | | | | REC | | | | |
| Incineration | | | | | | | | | | REQ[3] | | | | | | | |
| Either | REQ | REC | REC | REQ | REQ | REQ | REC | REC | REQ | | REC | REQ | | REC | REC | REC | REC |
| ▶ Does your state regulate infectious waste as a hazardous waste? | N | N | N | N | N | Y | N | N | N | N | N | Y | N | N | N | N | N |
| ▶ Does your state impose hospital infectious waste regulations on other generators? | Y | N | N | N | Y | Y | N | N | N | Y | N | N | N | N | N | N | N |
| ▶ Does your state regulate the transportation of untreated infectious wastes? | Y | N | N | Y | Y | Y | N | N | N | N | N | Y | N | N | Y | N | N |
| ▶ Is your state expecting infectious waste legislation or regulations in the next year? | N | N | N | Y | Y | Y | Y | N | Y | Y | N | Y | Y | N | Y | Y | N |

[3] Hospital licensure rules say that only infectious body parts require incineration.

States Expecting Legislative or Regulatory Action on Infectious Wastes in the Next Year


☒ No rules in place, expecting action
☐ Rules in place, expecting action
☐ No action expected

(De Castro, 1988)

Transportation Requirements

Of the states with regulations for the management of infectious wastes, eleven have enforcable requirements for the shipment and transportation of infectious wastes to off-site treatment or disposal facilities. Requirements under these regulations include, but are not restricted to, packaging and labelling of wastes, storage requirements and conditions, and the manifesting of infectious waste shipments. Three states with infectious waste guides, have guidelines for the same purpose.

### 7.2.2.2 B.C. Biomedical Task Force Survey of U.S. Legislation For Biomedical Wastes

1. Existence of Legislation Addressing Infectious Wastes

- 8 states currently have legislation for biomedical wastes
- 3 states regulate biomedical wastes as a hazardous waste; 1 state proposes to

- 13 states have issued draft regulations

- 4 states have no regulations.

It should be noted that a state which indicates that it regulates biomedical wastes does not necessarily have a separate biomedical waste management program. In many cases, states have included the management of biomedical wastes under existing waste management and/or hospital license statutes.

A summary of state legislative requirements is given in Appendix 7.3

2. Administrator of Infectious Waste Regulations

For the purpose of regulation administration, the agencies with enforcement authority were divided among Departments for Health and Departments for the Environment as follows:

- 12 states are regulated by Departments of Health
- 8 states are regulated by Department of Environment
- 8 states have joint regulations administered by Departments of Health and Departments of Environment.

3. Are Infectious Wastes Defined in State Regulations

- 18 states have definitions of infectious wastes for regulatory purposes
- 10 states have no definition of infectious wastes for regulatory purposes

Definitions of biomedical wastes were found to differ from state to state. Categories and examples of biomedical wastes recognized by state and county agencies are given in Appendix 7.4.

4. Applicability of Legislation

Hospitals are the main generator sources of regulatory concern, however, twenty states also require other generators of biomedical wastes to follow biomedical waste regulations. A summary of generators recognized by state agencies as producing biomedical wastes is given in Appendix 7.5.

## 5. Exemptions From Biomedical Waste Regulations

The states of California, Missouri and New York exempt generators of less than 100 kilograms per month from regulation requirements. Ohio proposes to exempt generators of less than 22.7 kilograms (50 pounds) per month. Indiana may grant generator exemptions

## 6. Handling, Storage and Packaging Requirements for Biomedical Wastes

Only twelve states with regulations or guidelines require that biomedical wastes be segregated from other wastes at the point of waste generation.

On-site storage requirements for biomedical wastes were included in nineteen of the state regulations.

On-site storage requirements typically include duration of waste storage and required storage temperatures for wastes prior to treatment or disposal; restricted access to storage areas; requirements for carts or containers used to transport wastes on-site; and the labelling of all containers, bags and access doors to the storage area used for biomedical wastes, with the words "infectious waste" and/or with the international biohazard symbol.

Nineteen states require that biomedical wastes other than sharps be afforded special packaging requirements prior to wastes being treated or disposed of. Containment measures required typically include double bagging of wastes in impervious, tear resistant plastic bags of individual thickness of 1.5-3.0 mils and each bag must be securely tied. Single bags of thickness 3.0-6.0 mils are often accepted in place of double bagging. California state regulations require that plastic bags be made of material of sufficient single-thickness to pass the 165 gram dropped dart impact resistance test.

Bags for infectious wastes are generally required to be red or orange and conspicuously labelled with "infectious waste" and labelled with the international biohazard symbol. Chemotherapeutic wastes are subject to the same requirements as infectious wastes; however, bags are generally required to be yellow and labelled "Chemotherapeutic waste" and carry the international biohazard symbol.

Where biomedical wastes are to be placed inside of fibreboard containers or other secondary containers that prevent seepage or release of wastes, some states permit wastes to be packaged in plastic bags meeting single bag thickness requirements of 1.5-3.0 mils, while other states require wastes to be double bagged prior to being placed in such containers.

Twenty-one states require that used sharps be disposed of intact in rigid plastic, glass, heavy cardboard or metal containers and that such containers be tightly lidded or taped closed when full and conspicuously labelled as containing sharps.

7. Treatment and Disposal Requirements for Biomedical Wastes

Incineration and autoclaving are the most commonly accepted methods for the treatment of biomedical wastes. However, as indicated in Appendix 7.6, numerous states also permit the use of other sterilization or treatment methods for biomedical wastes, including but not restricted to thermal inactivation, chemical disinfection and irradiation.

Preceded by acceptable treatment methods, most states permit the disposal of biomedical wastes, rendered non-infectious, at municipal landfills. However, five states permit the disposal of untreated biomedical wastes at municipal landfills.

Only nine states with regulations or proposed regulations (Arkansas, California, New Jersey, New York, Pennsylvania, South Carolina, Texas and Virginia) have specified that pathological wastes, usually defined as human tissues, body parts and organs removed surgically or at autopsy, may only be disposed of by incineration, cremation or burial. Other states permit such wastes to be treated and disposed of by other methods.

Ten states permit the discharge of liquid and semi-liquid wastes, such as blood, blood products, suction fluids, excretions and secretions to the municipal sewer, provided municipalities permit such disposal practices.

Treatment and disposal of biomedical wastes is not solely restricted to on-site facilities, most states generally allow off-site treatment or disposal of these wastes at facilities permitted to handle these wastes. Only Arkansas, Hawaii and Indiana regulations require that biomedical waste be treated and disposed of on-site.

8. Transportation Requirements for Biomedical Waste Shipments

- 10 states require manifesting of all biomedical waste shipments.
- 8 states require transporters of biomedical wastes to be licensed or registered.
- 6 states require both manifesting of shipments and the licensing or registration of biomedical waste haulers.
- Tennessee and Indiana require written contracts between generators and treatment facilities.

### 7.2.3 County Legislation

1. Existence of Legislation Addressing Infectious Wastes

Three responses from the United States included legislation enacted by state counties for the management of biomedical wastes. These included: Anchorage, Alaska; Marion County, Indiana and Seattle King County, Washington.

2. Administrator of Infectious Waste Regulations

- Marion County and Seattle King County regulations are administered by Departments of Health.
- Anchorage regulations do not state which agency has administrative responsibility.

3. Are Infectious Wastes Defined in County Regulations

For regulatory purposes both Marion County and Seattle King County have a definition of infectious waste. Categories and examples of biomedical wastes recognized by county agencies are given in Appendix 7.4.

4. Applicability of Legislation

Marion County and Seattle King County regulations are applicable to hospitals and other generators of biomedical wastes. A summary of generators recognized by these counties as producing biomedical wastes is given in Appendix 7.5.

5. Handling, Storage and Packaging Requirements for Biomedical Wastes

- Neither Marion County nor Seattle King County regulations require that biomedical wastes be segregated from other wastes at the point of origin.
- Both Marion County and Seattle King County require that biomedical wastes other than sharps be afforded special packaging requirements prior to wastes being treated or disposed of.
- Marion County and Seattle King County require that used sharps be disposed of intact in rigid, puncture proof containers and that such containers be tightly lidded or taped closed and conspicuously labelled as containing sharps.
- Legislation from Anchorage does not address these requirements.

6. Treatment and Disposal Requirements for Biomedical Wastes

- Incineration and autoclaving are acceptable methods for the treatment of biomedical wastes in all three counties.
- Anchorage and Marion County legislations also permit the use of thermal inactivation and chemical disinfection as acceptable treatment methods.
- Marion County legislation permits irradiation of biomedical wastes, while Seattle King County legislation permits that biomedical wastes may be treated by retort.
- Only Seattle King County legislation permits the discharge of liquid and semi-liquid wastes to the municipal sewer.

7. Transportation Requirements for Biomedical Waste Shipments

Transportation requirements were not addressed in the county legislation received.

# APPENDIX 7.3

# B.C. BIOMEDICAL TASK FORCE SURVEY OF AMERICAN LEGISLATION FOR BIOMEDICAL WASTE

APPENDIX 7.3 B.C. BIOMEDICAL TASK FORCE SURVEY OF AMERICAN LEGISLATION FOR BIOMEDICAL WASTES

| | Alabama | Alaska | Arkansas | California | Connecticut | Delaware | Florida | Hawaii | Indiana | Kentucky |
|---|---|---|---|---|---|---|---|---|---|---|
| Are there State Regulations for Infectious Wastes? | Y | Hazardous Waste | Y | Y | Proposed Special Waste | N | Y and Guidelines | Y | Proposed | Y |
| Is there a definition of Infectious Wastes? | N | Y | Y | Y | N | - | Y | Y | Y | N |
| What agency administers Infectious Waste Regulations or Guidelines? | Health | Environment | Health | Health | Environment | N | Environment and Health | Health | Health | Environment and Health |
| Is there any small quantity exemption for infectious waste generators? | N/A | N | N | Generators of <100 kg/mo | N | N | N | N | Only if approved | N |
| Are generators other than hospitals required to comply with regulations or guidelines? | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| Are wastes required to be segregated at the point of origin? | N/A | N/A | Y | Y | Y | N | N/A | N/A | N | Y |
| Do regulations/guidelines address on-site storage requirements? | N/A | N/A | Y | Y | Y | N | Y | Y | Y | Y |
| Are Infectious Wastes other than sharps subject to special handling requirements? | N/A | Y | Y | Y | N | N | Y | N | Y | N/A |
| Are sharps required to be contained in puncture-proof containers or otherwise contained? | N/A | Y | Y | Y | Y | N | Y | N | Y | Y |
| Are Infectious Wastes required to be treated or disposed of on-site? | N/A | N/A | Y | N | N | N | N/A | Y | Y | N |
| Are shipments of Infectious Wastes to off-site treatment or disposal facilities required to be manifested? | N/A | N/A | - | N | N | N | N/A | - | - | N/A |
| Are transporters of infectious waste required to be licensed or registered? | N/A | N/A | - | Y | N | N | N/A | - | - | N/A |

Y = Yes
N = No
N/A = Not Addressed

APPENDIX 7.3 B.C. BIOMEDICAL TASK FORCE SURVEY OF AMERICAN LEGISLATION FOR BIOMEDICAL WASTES

| | Maryland | Massachusetts | Michigan | Minnesota | Missouri | Montana | N. Hampshire | N. Jersey | N. Mexico | N. York |
|---|---|---|---|---|---|---|---|---|---|---|
| Are there State Regulations for Infectious Wastes? | Proposed | Proposed | Guidelines | Guidelines | Proposed | Hazardous Waste | Proposed | Y | Proposed | Y |
| Is there a definition of Infectious Wastes? | Y | Y | Y | Y | Y | N | N | N | Y | Y |
| What agency administers Infectious Waste Regulations or Guidelines? | Health | Health | Health | Health | Environment and Health | Environment | Environment | Environment and Health | Environment and Health | Environment and Health |
| Is there any small quantity exemption for infectious waste generators? | N | N | N | N | Generators of <100 kg/mo | N | N | N | N | Generators of <100 kg/mo |
| Are generators other than hospitals required to comply with regulations or guidelines? | Y | Y | Y | Y | N | Y | N/A | N | N | Y |
| Are wastes required to be segregated at the point of origin? | N | Y | N | N | Y | N/A | N/A | N/A | N | Y |
| Do regulations/guidelines address on-site storage requirements? | Y | Y | N | Y | Y | Y | N/A | N/A | N | Y |
| Are Infectious Wastes other than sharps subject to special handling requirements? | Y | Y | Y | Y | Y | Y | N/A | N/A | Y | Y |
| Are sharps required to be contained in puncture-proof containers or otherwise contained? | Y | Y | Y | Y | Y | Y | N/A | N/A | Y | Y |
| Are Infectious Wastes required to be treated or disposed of on-site? | N | N | N | N | N | N | N/A | N | N | N |
| Are shipments of Infectious Wastes to off-site treatment or disposal facilities required to be manifested? | N | Y | N | N | Y | Y | N/A | N/A | Y | Y |
| Are transporters of infectious waste required to be licensed or registered? | N | N | N | N | N | Y | N/A | N/A | Y | Y |

Y = Yes
N = No
N/A = Not Addressed

## APPENDIX 7.3 B.C. BIOMEDICAL TASK FORCE SURVEY OF AMERICAN LEGISLATION FOR BIOMEDICAL WASTES

|  | Ohio | Oregon | Pennsylvania | S. Carolina | S. Dakota | Tennessee | Texas | Utah | Virginia | Washington |
|---|---|---|---|---|---|---|---|---|---|---|
| Are there State Regulations for Infectious Wastes? | Proposed | Guidelines | Proposed | Proposed | N | Proposed | Proposed | N | Proposed | Dangerous/ Hazardous Waste |
| Is there a definition of Infectious Wastes? | Y | Y | Y | Y | N | Y | Y | N | Y | N |
| What agency administers Infectious Waste Regulations or Guidelines? | Health | Environment | Environment | Environment and Health | - | Environment and Health | Health | - | Environment | Environment |
| Is there any small quantity exemption for infectious waste generators? | Generators of ≤50 lbs/mo | N | N | N | N | N | N | N | N | N |
| Are generators other than hospitals required to comply with regulations or guidelines? | N | Y | Y | Y | N | Y | Y | N | Y | Y |
| Are wastes required to be segregated at the point of origin? | N | N | Y | Y | N | [illegible] | [illegible] | [illegible] | [illegible] | N |
| Do regulations/guidelines address on-site storage requirements? | N | Y | Y | Y | N | [illegible] | [illegible] | [illegible] | Y | Y |
| Are infectious wastes other than sharps subject to special handling requirements? | Y | N | Y | Y | N | [illegible] | [illegible] | [illegible] | Y | Y |
| Are sharps required to be contained in puncture-proof containers or otherwise contained? | Y | N | Y | Y | N | [illegible] | [illegible] | [illegible] | Y | Y |
| Are infectious wastes required to be treated or disposed of on-site? | N | Some | N | N | N | [illegible] | [illegible] | [illegible] | [illegible] | N |
| Are shipments of infectious wastes to off-site treatment or disposal facilities required to be manifested? | Y | N | N | Y | N | [illegible] | [illegible] | [illegible] | [illegible] | Y |
| Are transporters of infectious waste required to be licensed or registered? | Y | N | N | N | N | [illegible] | [illegible] | [illegible] | Y | Y |

Y = Yes
N = No
N/A = Not Addressed

APPENDIX 7.A D.C. BIOMEDICAL TASK FORCE SURVEY OF AMERICAN LEGISLATION FOR BIOMEDICAL WASTES

| | W. Virginia | Wisconsin | Wyoming | Marion County, Indiana | King County Washington |
|---|---|---|---|---|---|
| Are there State Regulations for Infectious Wastes? | Proposed | Guidelines | N | Y | Proposed |
| Is there a definition of Infectious Wastes? | Y | Y | N | Y | N |
| What agency administers Infectious Waste Regulations or Guidelines? | Health | Environment | - | Health | Health |
| Is there any small quantity exemption for infectious waste generators? | N | N | N | N | N |
| Are generators other than hospitals required to comply with regulations or guidelines? | Y | Y | N | Y | Y |
| Are wastes required to be segregated at the point of origin? | Y | N | N | N | N |
| Do regulations/guidelines address on-site storage requirements? | Y | Y | N | Y | Y |
| Are Infectious Wastes other than sharps subject to special handling requirements? | Y | Y | N | Y | Y |
| Are sharps required to be contained in puncture-proof containers or otherwise contained? | Y | Y | N | Y | Y |
| Are Infectious Wastes required to be treated or disposed of on-site? | N | N | N | N | N |
| Are shipments of Infectious Wastes to off-site treatment or disposal facilities required to be manifested? | Y | N | N | N | N |
| Are transporters of infectious waste required to be licensed or registered? | N | N | N | N | N |

Y = Yes
N = No
N/A = Not Addressed

# APPENDIX 7.4

## CATEGORIES OF BIOMEDICAL WASTE INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

APPENDIX 7.4: CATEGORIES OF BIOMEDICAL WASTES INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Biomedical Waste Category | Examples | Alabama | Alaska | Arkansas | California | Connecticut | Florida | Hawaii |
|---|---|---|---|---|---|---|---|---|
| Isolation wastes | • refer to Centers for Disease Control (CDC), Guidelines for Isolation Precautions in Hospitals, July 1983 |  | ✓ | ✓ |  |  | ✓ |  |
| Cultures and stocks of infectious agents and associated biologicals | • specimens from medical and pathology laboratories |  | ✓ |  | ✓ |  | ✓ |  |
|  | • cultures and stocks of infectious agents from clinical, research, and industrial laboratories; disposable culture dishes, and devices used to transfer, inoculate and mix cultures |  | ✓ | ✓ | ✓ |  | ✓ |  |
|  | • wastes from production of biologicals |  | ✓ |  |  |  |  |  |
|  | • discarded live and attenuated vaccines |  | ✓ |  |  |  | ✓ |  |
| Human blood and blood products | • waste blood, serum, plasma, and blood products |  | ✓ | ✓ |  |  |  |  |
| Pathological waste | • tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy |  | ✓ | ✓ | ✓ |  | ✓ |  |
| Sharps | • Hypodermic needles, syringes, scalpel blades, pasteur pipettes, and broken glass |  | ✓ | ✓ |  | ✓ | ✓* |  |
| Contaminated animal carcasses, body parts and bedding | • contaminated animal carcasses, body parts, and bedding of animals intentionally exposed to pathogens |  | ✓ |  | ✓ |  |  |  |
| Surgery and autopsy wastes | • soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves |  | ✓ | ✓ | ✓ |  |  |  |
| Miscellaneous laboratory wastes | • specimen containers, slides, and cover slips; disposable gloves, la coats, and aprons |  | ✓ | ✓ | ✓ |  |  |  |
| Dialysis unit wastes | • tubing, filters, disposable sheets, towels, gloves, aprons, and lab coats |  | ✓ | ✓ | ✓ |  |  |  |
| Contaminated equipment | • equipment used in patient care, medical laboratories, research, and in the production and testing of certain pharmaceuticals |  | ✓ | ✓ | ✓ |  |  |  |
| Other |  |  |  | • Antinoplastics<br>• AIDs<br>• Radioactive |  |  | *only if classified infectious |  |

APPENDIX 7.4: CATEGORIES OF BIOMEDICAL WASTES INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Biomedical Waste Category | Examples | Draft Code 009 Indiana | Kentucky | Maryland | Massachusetts | Michigan | Minnesota | Missouri |
|---|---|---|---|---|---|---|---|---|
| Isolation wastes | • refer to Centers for Disease Control (CDC), Guidelines for Isolation Precautions in Hospitals, July 1983 | ✓ | ✓ |  | ✓ | ✓ | ✓ | ✓ |
| Cultures and stocks of infectious agents and associated biologicals | • specimens from medical and pathology laboratories |  |  | ✓ | ✓ | ✓ | ✓ |  |
|  | • cultures and stocks of infectious agents from clinical, research, and industrial laboratories; disposable culture dishes, and devices used to transfer, inoculate and mix cultures | ✓ |  |  | ✓ | ✓ | ✓ | ✓ |
|  | • wastes from production of biologicals | ✓ |  |  | ✓ | ✓ |  | ✓ |
|  | • discarded live and attenuated vaccines |  |  |  | ✓ |  |  |  |
| Human blood and blood products | • waste blood, serum, plasma, and blood products | ✓ |  |  | ✓ |  |  | ✓ |
| Pathological waste | • tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sharps | • Hypodermic needles, syringes, scalpel blades, pasteur pipettes, and broken glass | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Contaminated animal carcasses, body parts and bedding | • contaminated animal carcasses, body parts, and bedding of animals intentionally exposed to pathogens | ✓ |  | ✓ | ✓ |  | ✓ | ✓ |
| Surgery and autopsy wastes | • soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves | ✓ | ✓ |  | ✓ | ✓ | ✓ |  |
| Miscellaneous laboratory wastes | • specimen containers, slides, and cover slips; disposable gloves, la coats, and aprons |  | ✓ | ✓ | ✓ | ✓ |  |  |
| Dialysis unit wastes | • tubing, filters, disposable sheets, towels, gloves, aprons, and lab coats |  |  |  | ✓ |  | ✓ | ✓ |
| Contaminated equipment | • equipment used in patient care, medical laboratories, research, and in the production and testing of certain pharmaceuticals |  |  |  | ✓ |  |  |  |
| Other |  |  |  |  |  |  |  |  |

## APPENDIX 7.4: CATEGORIES OF BIOMEDICAL WASTES INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Biomedical Waste Category | Examples | New Hampshire | N. Jersey | Draft Act N. Mexico | Draft Act New York | Ohio | Oregon | Pennsylvania |
|---|---|---|---|---|---|---|---|---|
| Isolation wastes | • refer to Centers for Disease Control (CDC), Guidelines for Isolation Precautions in Hospitals, July 1983 | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Cultures and stocks of infectious agents and associated biologicals | • specimens from medical and pathology laboratories | | | | ✓ | ✓ | ✓ | ✓ |
| | • cultures and stocks of infectious agents from clinical, research, and industrial laboratories; disposable culture dishes, and devices used to transfer, inoculate and mix cultures | ✓ | | | ✓ | ✓ | ✓ | ✓ |
| | • wastes from production of biologicals | | | | ✓ | ✓ | ✓ | ✓ |
| | • discarded live and attenuated vaccines | | | | ✓ | ✓ | ✓ | ✓ |
| Human blood and blood products | • waste blood, serum, plasma, and blood products | ✓ | | | ✓ | ✓ | ✓ | ✓ |
| Pathological waste | • tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sharps | • Hypodermic needles, syringes, scalpel blades, pasteur pipettes, and broken glass | ✓ | | | ✓ | ✓ | ✓ | ✓ |
| Contaminated animal carcasses, body parts and bedding | • contaminated animal carcasses, body parts, and bedding of animals intentionally exposed to pathogens | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| Surgery and autopsy wastes | • soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| Miscellaneous laboratory wastes | • specimen containers, slides, and cover slips; disposable gloves, la coats, and aprons | ✓ | | | ✓ | | | ✓ |
| Dialysis unit wastes | • tubing, filters, disposable sheets, towels, gloves, aprons, and lab coats | ✓ | | | ✓ | | | |
| Contaminated equipment | • equipment used in patient care, medical laboratories, research, and in the production and testing of certain pharmaceuticals | | | ✓ | | | | ✓ |
| Other | | | | | | | | |

## APPENDIX 7.4: CATEGORIES OF BIOMEDICAL WASTES INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Biomedical Waste Category | Examples | Wyoming | Anchorage Alaska | Marion County Indiana | Seattle-King County Washington |
|---|---|---|---|---|---|
| Isolation wastes | • refer to Centers for Disease Control (CDC), Guidelines for Isolation Precautions in Hospitals, July 1983 |  | ✓ |  |  |
| Cultures and stocks of infectious agents and associated biologicals | • specimens from medical and pathology laboratories |  | ✓ |  |  |
|  | • cultures and stocks of infectious agents from clinical, research, and industrial laboratories; disposable culture dishes, and devices used to transfer, inoculate and mix cultures |  | ✓ | ✓ |  |
|  | • wastes from production of biologicals |  | ✓ | ✓ |  |
|  | • discarded live and attenuated vaccines |  | ✓ | ✓ |  |
| Human blood and blood products | • waste blood, serum, plasma, and blood products |  | ✓ | ✓ |  |
| Pathological waste | • tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy |  | ✓ | ✓ |  |
| Sharps | • Hypodermic needles, syringes, scalpel blades, pasteur pipettes, and broken glass |  | ✓ | ✓ |  |
| Contaminated animal carcasses, body parts and bedding | • contaminated animal carcasses, body parts, and bedding of animals intentionally exposed to pathogens |  | ✓ | ✓ |  |
| Surgery and autopsy wastes | • soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves |  | ✓ | ✓ |  |
| Miscellaneous laboratory wastes | • specimen containers, slides, and cover slips; disposable gloves, la coats, and aprons |  | ✓ | ✓ |  |
| Dialysis unit wastes | • tubing, filters, disposable sheets, towels, gloves, aprons, and lab coats |  | ✓ |  |  |
| Contaminated equipment | • equipment used in patient care, medical laboratories, research, and in the production and testing of certain pharmaceuticals |  | ✓ |  |  |
| Other |  |  |  |  |  |

# APPENDIX 7.5

## RECOGNIZED GENERATORS OF BIOMEDICAL WASTES AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

## APPENDIX 7.5: RECOGNIZED GENERATORS OF BIOMEDICAL WASTES AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Generating Sources | Alabama | Alaska | Arkansas | California | Connecticut | Florida | Hawaii | Draft Code 009 Indiana |
|---|---|---|---|---|---|---|---|---|
| Hospitals | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| (Community) Health Care Facilities | | | | ✓ | ✓ | ✓ | | ✓ |
| Doctor's Clinics | | | | | | | | ✓ |
| Dental Surgeons | | | | | | | | |
| Clinical, Research & Teaching Laboratories | | | | | ✓ | ✓ | ✓ | ✓ |
| Veterinary & Other Animal Care Facilities | | | | | | | ✓ | ✓ |
| Mortuaries & Funeral Homes | | | | | | | | |
| Coroner Offices | | | | | | | | |
| Pharmaceutical Suppliers | | | | | | | | |
| Crematoria | | | | | | | | ✓ |
| Blood Banks | | | | | | | | ✓ |
| Others | •Nursing Homes | •Any Generator | •Related Institutions | •Any Generator<br>•Chronic Dialysis Clinics | | •Renal Dialysis Centers | •Medical Facilities Generating Infectious and pathological wastes | •Ambulatory Surgical Facilities<br>•Diet Clinics |

APPENDIX 7.5: RECOGNIZED GENERATORS OF BIOMEDICAL WASTES AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Generating Sources | Kentucky | Maryland | Massachusetts | Michigan | Minnesota | Missouri | New Jersey | New Mexico |
|---|---|---|---|---|---|---|---|---|
| Hospitals | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| (Community) Health Care Facilities | ✓ | ✓ |  | ✓ | ✓ |  |  |  |
| Doctor's Clinics |  | ✓ |  |  |  |  |  |  |
| Dental Surgeons |  |  |  |  |  |  |  |  |
| Clinical, Research & Teaching Laboratories | ✓ | ✓ | ✓ | ✓ |  |  |  |  |
| Veterinary & Other Animal Care Facilities |  | ✓ |  |  |  |  |  |  |
| Mortuaries & Funeral Homes |  |  |  |  |  |  |  |  |
| Coroner Offices |  |  |  |  |  |  |  |  |
| Pharmaceutical Suppliers |  |  |  |  |  |  |  |  |
| Crematoria |  |  |  |  |  |  |  |  |
| Blood Banks |  |  |  |  |  |  |  |  |
| Others |  | •Licensed Medical Facilities |  |  |  |  |  |  |

APPENDIX 7.5: RECOGNIZED GENERATORS OF BIOMEDICAL WASTES AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Generating Sources | Draft Act N. York | Ohio | Oregon | Pennsylvania | S. Carolina | Tennessee | Texas | Virginia |
|---|---|---|---|---|---|---|---|---|
| Hospitals | | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| (Community) Health Care Facilities | | | | | | ✓ | ✓ | |
| Doctor's Clinics | | | | | | | ✓ | |
| Dental Surgeons | | | | | | | | |
| Clinical, Research & Teaching Laboratories | | | | ✓ | ✓ | | ✓ | |
| Veterinary & Other Animal Care Facilities | | | | ✓ | | | ✓ | |
| Mortuaries & Funeral Homes | | | | | | | | |
| Coroner Offices | | | | | | | | |
| Pharmaceutical Suppliers | | | | ✓ | | | | |
| Crematoria | | | | | | | | |
| Blood Banks | | | | | | | | |
| Others | •Any Generator | •Any Generator | •Other Medical Facilities | | | •Ambulatory Surgical Treatment Centers | •Chronic Dialysis Clinics<br>•Acute Psychiatric Hospitals<br>•Health Maintenance Organizations | •Any Generator |

APPENDIX 7.5: RECOGNIZED GENERATORS OF BIOMEDICAL WASTES AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Generating Sources | Washington | West Virginia | Wisconsin | Wyoming | Marion County Indiana | Seattle-King County Washington |
|---|---|---|---|---|---|---|
| Hospitals | | | ✓ | | ✓ | ✓ |
| (Community) Health Care Facilities | | | ✓ | | ✓ | ✓ |
| Doctor's Clinics | | | | | ✓ | ✓ |
| Dental Surgeons | | | | | ✓ | ✓ |
| Clinical, Research & Teaching Laboratories | | | | | ✓ | ✓ |
| Veterinary & Other Animal Care Facilities | | | | | | ✓ |
| Mortuaries & Funeral Homes | | | | | ✓ | ✓ |
| Coroner Offices | | | | | | |
| Pharmaceutical Suppliers | | | | | ✓ | ✓ |
| Crematoria | | | | | | |
| Blood Banks | | | | | ✓ | |
| Others | •Generators | •Any Generator | | | •Ambulatory Surgical Facilities | •Nursing Care Facilities |

# APPENDIX 7.6

# ACCEPTABLE TREATMENT PRACTICES FOR BIOMEDICAL WASTES PRIOR TO LANDFILL DISPOSAL AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

APPENDIX 7.6: ACCEPTABLE TREATMENT PRACTICES FOR BIOMEDICAL WASTES PRIOR TO LANDFILL DISPOSAL AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Acceptable Treatment Practices | Alabama | Alaska | Arkansas | California* | Connecticut | Florida | Hawaii | Draft Code 009 Indiana |
|---|---|---|---|---|---|---|---|---|
| Incineration | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Steam Sterilization (Autoclaving) |  | ✓ | ✓ | ✓ |  |  | ✓ | ✓ |
| Thermal Inactivation |  | ✓ |  |  |  |  |  | ✓ |
| Chemical Disinfection |  | ✓ |  |  |  |  |  | ✓ |
| Others | •Other Appropriate Methods |  | •Irradiation |  |  | •Other Approved Methods | •Not stated | •Irradiation |

* For the purpose of biomedical waste disposal the California Department of Health Services permits disposal at Class I or Class II Landfill Facilities.

APPENDIX 7.6: ACCEPTABLE TREATMENT PRACTICES FOR BIOMEDICAL WASTES PRIOR TO LANDFILL DISPOSAL AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Acceptable Treatment Practices | Kentucky | Maryland | Massachusetts | Michigan | Minnesota | Missouri | New Hampshire | New Jersey |
|---|---|---|---|---|---|---|---|---|
| Incineration | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Steam Sterilization (Autoclaving) | ✓ |  | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Thermal Inactivation |  |  |  |  |  |  |  |  |
| Chemical Disinfection |  |  |  |  |  |  | ✓ |  |
| Others |  |  | •Gas Sterilization |  | •Other Approved Methods | •Other Approved Methods | •Gas Sterilization |  |

APPENDIX 7.6: ACCEPTABLE TREATMENT PRACTICES FOR BIOMEDICAL WASTES PRIOR TO LANDFILL DISPOSAL AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Acceptable Treatment Practices | New Mexico | Draft Act New York | Ohio | Oregon | Pennsylvania | South Carolina | Tennessee | Texas |
|---|---|---|---|---|---|---|---|---|
| Incineration |  | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Steam Sterilization (Autoclaving) |  |  | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Thermal Inactivation |  |  |  |  | ✓ |  |  |  |
| Chemical Disinfection |  |  |  |  | ✓ | ✓ |  |  |
| Others |  | •Other Approved Methods |  |  | •Irradiation | •Gas Sterilization | •Other Disinfection or Sterilization Methods | •Other Approved Sterilization Methods |

APPENDIX 7.6: ACCEPTABLE TREATMENT PRACTICES FOR BIOMEDICAL WASTES PRIOR TO LANDFILL DISPOSAL AS INCLUDED IN AMERICAN BIOMEDICAL WASTE LEGISLATION

| Acceptable Treatment Practices | Virginia | Washington* | West Virginia* | Wisconsin | Wyoming | Anchorage Alaska | Marion County Indiana | Seattle-King County Washington |
|---|---|---|---|---|---|---|---|---|
| Incineration | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Steam Sterilization (Autoclaving) | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Thermal Inactivation | | | | | | ✓ | ✓ | |
| Chemical Disinfection | | | | ✓ | | ✓ | ✓ | |
| Others | | | | •Grinding, melting, pulverizing sharps | | | •Irradiation | •Retort<br>•Other Approved Methods |

* For the purpose of biomedical waste disposal Washington and West Virginia require the disposal of biomedical wastes at Hazardous Waste Facilities/Landfills.

# APPENDIX 7.7

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# APPENDIX 8.0

## GENERAL BIOMEDICAL GUIDES

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# APPENDIX 8.1

# CANADIAN GUIDELINES

APPENDIX 8.1

TABLE A8.1

## RECOMMENDED MANAGEMENT STRATEGIES FROM CANADIAN BIOMEDICAL GUIDELINES - HUMAN ANATOMICAL

| Options | | CSA | CRCS | Ontario |
|---|---|---|---|---|
| Recommended Packaging Requirements | 1. Leak and puncture resistant bag | X | | X |
| | 2. Double bagged | | | X |
| | 3. Containers | | | X |
| | 4. Labelled | | | X |
| | 5. Colour coded | Red | | Red |
| Recommended Storage Requirements | 1. Restricted access | X | Compliance with Provincial Legislation | X |
| | 2. Maintain package integrity | | | X |
| | 3. Secured entrance | X | | X |
| | 4. Identification of storage area, sights, postings | | | X |
| | 5. Duration of storage | X | X | X |
| | 6. Temperature of storage | X | X | X |
| Recommended Treatment Practices | 1. Autoclav | | | |
| | 2. Gas/vapor sterilization | | | |
| | 3. Thermal inactiviation | | | |
| | 4. Chemical disinfection | | | |
| | 5. Irradiation | | | |
| Recommended Disposal Practices | 1. Incineration | X | | X |
| | 2. Compaction | | | |
| | 3. With normal refuse | | | |
| | 4. Grind and sewage | | | |
| | 5. Landfill | | | |
| | 6. Othe | | | |
| Recommended Off-Site Transport | 1. Packaging wastes in hardshell container | | Compliance with TDGA | X |
| | 2. Container colour coded | | | X |
| | 3. Appropriate biohazard symbol and label | | | X |
| | 4. Manifest shipments | | | X |
| | 5. Valid transport certificate | | | X |

# APPENDIX 8.1

## TABLE A8.2
## RECOMMENDED MANAGEMENT STRATEGIES FROM CANADIAN BIOMEDICAL GUIDELINES - ANIMAL ANATOMICAL

| Options | | CSA | CRCS | Ontario |
|---|---|---|---|---|
| Recommended Packaging Requirements | 1. Leak and puncture resistant bag | X | | X |
| | 2. Double bagged | | | |
| | 3. Containers | | | X |
| | 4. Labelled | | | X |
| | 5. Colour coded | Orange/red or blue[1] | | Orange |
| Recommended Storage Requirements | 1. Restricted access | X | Compliance with Provincial Legislation | X |
| | 2. Maintain package integrity | | | X |
| | 3. Secured entrance | X | | X |
| | 4. Identification of storage area, sights, postings | | | X |
| | 5. Duration of storage | X | X | X |
| | 6. Temperature of storage | X | X | X |
| Recommended Treatment Practices | 1. Autoclave | X | | X |
| | 2. Gas/vapor sterilization | | | |
| | 3. Thermal inactiviation | | | |
| | 4. Chemical disinfection | | | |
| | 5. Irradiation | | | |
| Recommended Disposal Practices | 1. Incineration | X | | X |
| | 2. Compaction | | | |
| | 3. With normal refuse | | | |
| | 4. Grind and sewage | | | |
| | 5. Landfill | X[1] | | |
| | 6. Other | X[1] | | |
| Recommended Off-Site Transport | 1. Packaging wastes in hardshell container | | Compliance with TDGA | X |
| | 2. Container colour coded | | | X |
| | 3. Appropriate biohazard symbol and label | | | X |
| | 4. Manifest shipments | | | X |
| | 5. Valid transport certificate | | | X |

[1] non-infectious animal anatomical wastes

# APPENDIX 8.1

## TABLE A8.3

## RECOMMENDED MANAGEMENT STRATEGIES FROM CANADIAN BIOMEDICAL GUIDELINES - INFECTIOUS NONANATOMICAL

| Options | | CSA | CRCS | Ontario |
|---|---|---|---|---|
| Recommended Packaging Requirements | 1. Leak and puncture resistant bag | X | X | X |
| | 2. Double bagged | | | |
| | 3. Containers | X(1&2) | | X(1&2) |
| | 4. Labelled | | | X |
| | 5. Colour coded | Yellow | Yellow(4) | Yellow |
| Recommended Storage Requirements | 1. Restricted access | X | Compliance with Provincial Legislation | X |
| | 2. Maintain package integrity | | | X |
| | 3. Secured entrance | X | | X |
| | 4. Identification of storage area, sights, postings | | | X |
| | 5. Duration of storage | X | X | X |
| | 6. Temperature of storage | X | X | X |
| Recommended Treatment Practices | 1. Autoclave | X | X | X |
| | 2. Gas/vapor sterilization | | | |
| | 3. Thermal inactiviation | | | |
| | 4. Chemical disinfection | | | |
| | 5. Irradiation | | | |
| Recommended Disposal Practices | 1. Incineration | X | | X |
| | 2. Compaction | | | |
| | 3. With normal refuse | | | |
| | 4. Grind and sewage | X(1) | X | X(1&3) |
| | 5. Landfill | | X(1) | |
| | 6. Other | | | |
| Recommended Off-Site Transport | 1. Packaging wastes in hardshell container | | Compliance with TDGA | X |
| | 2. Container colour coded | | | X |
| | 3. Appropriate biohazard symbol and label | | | X |
| | 4. Manifest shipments | | | X |
| | 5. Valid transport certificate | | | X |

(1) liquid wastes

(2) prior to being placed in a waste container colour-coded yellow

(3) high risk liquid wastes must be incinerated

(4) wastes may be placed in black bag following autoclaving

APPENDIX 8.1

TABLE A8.4

RECOMMENDED MANAGEMENT STRATEGIES FROM CANADIAN BIOMEDICAL GUIDELINES - SHARPS

| Options | | CSA | CRCS | Ontario |
|---|---|---|---|---|
| Recommended Packaging Requirements | 1. Hard shell, puncture resistant container | X | X | X |
| | 2. Box or carton | | | |
| | 3. Labelled "SHARPS" or "BIOHAZARD" | X | X | |
| | 4. Tightly lidded | X | | |
| | 5. Colour | Black/Dark Green[1] | Yellow | Black |
| | 6. Lid inhibits content removal | X | | |
| | 7. Plastic bags | | | |
| Recommended Storage Requirements | 1. Restricted access | X | Compliance with Provincial Legislation | X |
| | 2. Maintain package integrity | | | X |
| | 3. Secured entrance | X | | X |
| | 4. Identification of storage area, sights, postings | | | X |
| | 5. Duration of storage | X | X | X |
| | 6. Temperature of storage | X | X | X |
| Recommended Treatment Practices | 1. Autoclave | | X | |
| | 2. Gas/vapor sterilization | | | |
| | 3. Thermal inactiviation | | | |
| | 4. Chemical disinfection | | | |
| | 5. Irradiation | | | |
| Recommended Disposal Practices | 1. Incineration | X | X | |
| | 2. Compaction | | | |
| | 3. With normal refuse | | | |
| | 4. Grinding | | | X |
| | 5. Landfill | X | X[2] | |
| | 6. Other | X | | |
| Recommended Off-Site Transport | 1. Packaging wastes in hardshell container | | Compliance with TDGA | X |
| | 2. Container colour coded | | | X |
| | 3. Appropriate biohazard symbol and label | | | X |
| | 4. Manifest shipments | | | X |
| | 5. Valid transport certificate | | | X |

[1] For landfill disposal of sharps containers

[2] Landfill only following approved treatment practices

# APPENDIX 8.2

## 8.2 AMERICAN GUIDELINES

### 8.2.1 Federal Guidelines

Generator Sources To Which Guidelines Apply

The EPA identifies 7 types of facilities as potential generators of biomedical wastes, while the CDC guidelines apply only to hospitals, as shown in Table A8.5.

Categories of Biomedical Wastes

- EPA identifies 10 categories of biomedical wastes (6 categories are recommended as being designated biomedical wastes and 4 categories are identified as optional).
- CDC identifies 5 categories of biomedical wastes.

A summary of waste categories defined as biomedical wastes is repeated in Table A8.6.

Packaging and Labelling of Biomedical Wastes

- EPA guide specifies that wastes should be segregated at the point of generation; CDC guidelines do not address this issue.
- EPA guide recommends that all containers, bags, etc., used for biomedical wastes be labelled with the universal biohazard symbol and that plastic bags red or orange; CDC guidelines do not address this matter.
- CDC guidelines indicate that pathological wastes, isolation wastes, wound suction, urinary drainage, disposable dialysis membrane and contaminated slide or tubes should be double bagged prior to treatment or disposal.
- EPA guidelines indicate that adequate waste containment should be provided for a type of waste, as such single bags may not be sufficient and additional packaging should be used to preserve the integrity of the bag and to ensure containment of the waste. Options include:
    - double bagging
    - placement of single-bagged waste within a rigid or semi-rigid container such as a bucket, box or carton. When wastes are transported off-site for treatment plastic bags - single or double - should be placed within rigid or semi-rigid containers. All containers used for biomedical wastes should be colour coded or marked with the universal biohazard symbol.
- Both the CDC and EPA guides recommend that sharps be placed in impervious, puncture resistent rigid containers.
- EPA recommends liquid wastes be placed in capped or tightly stopped bottles or flasks.

Storage of Biomedical Wastes

- CDC guide recommends each hospital have special receptacles for wastes. Store areas should be kept clear.

## APPENDIX 8.2

## TABLE A8.5

## SOURCES OF BIOMEDICAL WASTES RECOGNIZED BY U.S. ENVIRONMENTAL PROTECTION AGENCY AND CENTRES FOR DISEASE CONTROL GUIDES

| Centres for Disease Control (CDC) | Environmental Protection Agency (EPA) |
|---|---|
| Hospitals | Hospitals<br>Medical Laboratories<br>Research Laboratories<br>Commercial Diagnostic Laboratories<br>Animal Experimentation Units<br>Industrial Plants and Laboratories<br>Other Facilities which Generate Infectious Waste (i.e. Biotechnology Companies) |

## APPENDIX 8.2

## TABLE A8.6

## CATEGORIES OF BIOMEDICAL WASTES RECOGNIZED BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY AND CENTRES FOR DISEASE CONTROL GUIDES

| UNITED STATES CENTRES FOR DISEASE CONTROL | UNITED STATES ENVIRONMENTAL PROTECTION AGENCY |
|---|---|
| Pathological Wastes<br>Microbiological<br>Blood, Blood products, Exudents and Secretions<br>Sharps<br>Isolation Wastes | Isolation Wastes<br>Cultures, Stocks, Biologicals<br>Human Blood and Blood Products<br>Pathological Wastes<br>Sharps<br>Contaminated Animal Carcasses, Body Parts & Bedding<br>Surgery and Autopsy Wastes<br>Miscellaneous Laboratory Wastes<br>Dialysis Unit Wastes<br>Contaminated Equipment |

- EPA guide recommends:
    - minimizing storage time
    - proper packaging to ensure wastes are contained and exclusion or rodent and vermin
    - limited access to storage areas
    - posting of universal biohazardous symbol on storage area doors, waste containers, freezers or fridges.

## Transport of Biomedical Wastes

- CDC and EPA guidelines recommend:
    - collection of biomedical wastes from within areas of generation in impervious carts for transport to the facility's storage area.
- EPA guidelines further recommend:
    - avoidance of mechanical loading devices which may rupture packaged wastes
    - placement of all biomedical wastes into rigid or semi-rigid containers before transport off-site
    - frequent disinfection of carts used to transfer wastes within the facility.

## Treatment of Biomedical Wastes

- A summary of recommended treatment options for biomedical wastes from the CDC and EPA guides is given in Table A8.7.
- The EPA guidelines further recommend:
    - establishing standard operating procedures for each process used for treating biomedical wastes
    - monitoring of all treatment processes to ensure efficient and effective treatment
    - use of biological indicators to monitor treatment

## Disposal of Biomedical Wastes

- A summary of recommended disposal options for biomedical waste from both the CDC and EPA guides is given in Table A8.8.
- Both guides recommend incineration as the disposal option of choice for the majority of biomedical wastes categories, however, landfill disposal of some categories of biomedical wastes are permitted by both agencies following acceptable treatment practices.
- CDC guidelines permit the landfill disposal of sharps following suitable packaging of these wastes, whereas, EPA guidelines indicate such wastes should be incinerated, or compacted or ground following autoclaving.
- Both the CDC and EPA guidelines indicate incineration as a suitable method for the disposal of anatomical wastes, however, the EPA guide also suggests such wastes may be disposed of by grinding to render such wastes unrecognizable following appropriate sterilization measures.

## APPENDIX 8.2

## TABLE A8.7

## RECOMMENDED TECHNIQUES FOR TREATMENT OF BIOMEDICAL WASTES FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY AND CENTRES FOR DISEASE CONTROL GUIDES

| Category of Biomedical Waste | Recommended Treatment Techniques | | | | | |
|---|---|---|---|---|---|---|
| | Treatment Sterilization | | Thermal Inactivation | | Chemical Disinfection | |
| | EPA[1] | CDC[2] | EPA | CDC | EPA | CDC |
| Isolation wastes | x | x | | | | |
| Cultures and stocks of infectious agents and associated biologicals | x | x | x | | x | |
| Human blood and blood products | x | | | | x | |
| Pathological Wastes | x | x | | | | |
| Contaminated Sharps | x | | | | | |
| Contaminated animal carcasses, body parts, bedding | | | | | | |
| - carcass & parts | x[3] | | | | | |
| - bedding | | | | | | |

[1] United States Environmental Protection Agency.

[2] United States Centres for Disease Control.

[3] For aesthetic reasons, steam sterilization should be followed by incineration of treated waste or by grinding with subsequent flushing to sewer in accordance with States and local regulations.

## APPENDIX 8.2

## TABLE A8.8

## RECOMMENDED DISPOSAL OF BIOMEDICAL WASTES FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY AND CENTRES OR DISEASE CONTROL GUIDES

| Category of Biomedical Waste | Recommended Treatment Techniques | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Incineration | | Discharge to sewer | | Landfill | | Other | |
| | EPA[1] | CDC[2] | EPA | CDC | EPA | CDC | EPA | CDC |
| Isolation wastes | x | x | | | | | | |
| Cultures and stocks of infectious agents and associated biologicals | x | x | | | | | | |
| Human blood and blood products | x | x | x | x | | | | |
| Pathological wastes | x | x | | | | | x[3,4] | |
| Contaminated sharps | x | | | | | x | | |
| Contaminated animal carcasses, body parts, bedding | | | | | | | | |
| - carcasses | x | | | | | | | x[3] |
| - bedding | x | | | | | | | |

---

[1] United States Environmental Protection Agency.

[2] United States Centres for Disease Control.

[3] Following steam sterilization treated waste may be ground with subsequent flushing to the sewer in accordance with State and local regulations.

[4] Handling by a mortician (burial or cremation).

### 8.2.2 States Guidelines

Generator Sources to Which Guidelines Apply

- 4 out of 5 State guidelines reviewed apply to hospitals and health care facilities.
- Florida and Oregon guides also apply to laboratories.
- Florida guidelines include dialysis centers, while Oregon guidelines include medical clinics.
- California guidelines apply to all generators of over 100 kilograms per month.

Categories of Biomedical Wastes

- A summary of waste categories included in States biomedical guidelines is given in Table A8.9.

Packaging and Labelling of Biomedical Wastes

- All States recommended sharps be placed intact into hardshell puncture resistant containers.
- Wastes other than sharps should be placed in red or orange bags, thickness generally not stated, and labelled with the international biohazard symbol.
- Florida and Minnesota guidelines recommend that all wastes excluding sharps be double bagged.

Storage and Biomedical Wastes

- Guides generally recommend the collection of wastes in dumpsters or bins with tight fitting lids. All such containers should be red or orange and should be labelled.
- All reusable containers should be sterilized following use.
- Wastes should not be compacted or transported by chute.
- Minnesota guidelines recommend that biomedical wastes be stored in a separate central storage area within the institute or stored outside in metal containers within a fenced enclosure. Access to storage areas should be restricted.
- Oregon guidelines state that potentially infectious wastes must not be stored longer than one week unless refrigerated.

Transport of Biomedical Wastes

- Biomedical wastes being transported off-site should be transported in leak-proof, fully enclosed containers or compartments and should be kept separate from other wastes.
- Several guides recommend that transport vehicles should be equipped with materials capable of handling spills.
- California guidelines state that transporters must be registered.

Treatment of Biomedical Wastes

- State guidelines generally did not address specific treatment methods for waste categories. Where reference was made to treatment of biomedical waste, guidelines generally referred to autoclaving wastes or sterilizing wastes.

## APPENDIX 8.2

## TABLE A8.9

## CATEGORIES OF BIOMEDICAL WASTES FROM AMERICAN STATES WITH GUIDELINES FOR BIOMEDICAL WASTES

| CALIFORNIA | MINNESOTA |
|---|---|
| Laboratory Waste<br>Pathological Wastes<br>Surgical Specimens<br>Contaminated Equipment<br>Human Dialysis Wastes<br>Contaminated Animal Carcasses<br>Sharps<br>Other Contaminated Materials | Isolation Wastes<br>Anatomical Wastes (Human & Animal)<br>Laboratory & Pathology Wastes<br>Bandages, Dressings, Catheters, Disposable Items<br>Other Wastes |

| OREGON | WISCONSIN |
|---|---|
| Surgical/Pathological Wastes<br>Sharps<br>Isolation Wastes<br>Blood and Blood Products<br>Biological Cultures<br>Other Laboratory Wastes | Laboratory Wastes<br>Pathological Specimens(1)<br>Disposable Fomites<br>Surgical Material From Out-Patient and Emergency Rooms<br>Contaminated Equipment, Utensils<br>Sharps |

(1) Includes: all tissue, specimens of blood elements, excretion and secretions.

A summary of recommended treatment options for biomedical waste is given in Table A8.10.

Disposal of Biomedical Wastes

- Incineration is the recommended method for disposal of biomedical wastes. Florida guidelines recommend that all wastes be incinerated.
- California, Oregon and Wisconsin guidelines permit the discharge of blood and blood products and liquid or semi-liquid wastes (excretions and secretions) to sewer.
- Oregon guidelines permit the disposal of isolation wastes, pathological wastes, sharps, blood and blood products, and contaminated solid wastes at landfills while California guidelines permit the disposal of pathological wastes, sharps and animal carcasses at Class I or II landfills only under the authority of a health officer.

A summary of recommended disposal options for biomedical wastes is given in Table A8.11.

APPENDIX 8.2

TABLE A8.10

## RECOMMENDED TECHNIQUES FOR THE TREATMENT OF BIOMEDICAL WASTES FROM AMERICAN STATES WITH GUIDELINES FOR BIOMEDICAL WASTES

| Category of Biomedical Waste | Recommended Disposal Practices | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Steam Sterilization | | | | | Thermal Inactivation | | | | | Chemical Inactivation | | | | | Other | | | | |
| | Cal | Flo | Min | Ore | Wis | Cal | Flo | Min | Ore | Wis | Cal | Flo | Min | Ore | Wis | Cal | Flo | Min | Ore | Wis |
| Isolation Wastes | | | | X | | | | | | | | | | | | | | | X | |
| Laboratory Wastes | | | X | | | | | | | | | | | | | | | | | |
| Pathological Wastes | | | | | X | | | | | | | | | | X | | | | | |
| Microbiological Wastes | X | | X | | | | | | | | | | | | | X | | | | |
| Sharps | X | | X | X | | | | | | | | | | | | | | | | |
| Blood, Blood Products | | | | X | | | | | | | | | | | | | | | | |
| Excretions & Secretions | | | | | | | | | | | | | | | | | | | | |
| Animal Carcasses & Body | | | | X | X | | | | | | | | | | | | | | | |
| Contaminated Equipment | | | | | | | | | | | | | | | | | | | | |
| Non-anatomical Wastes ie, gauze, dressing, tubing, etc. | | | X | | | | | | | | | | | | X | | | | | |

## APPENDIX 8.2

## TABLE A8.11

## RECOMMENDED TECHNIQUES FOR THE DISPOSAL OF BIOMEDICAL WASTES FROM AMERICAN STATES WITH GUIDELINES FOR BIOMEDICAL WASTES

| Category of Biomedical Waste | Recommended Disposal Practices | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Incineration | | | | | Discharge to Sewer | | | | | Landfill | | | | | Other | | | | |
| | Cal | Flo | Min | Ore | Wis | Cal | Flo | Min | Ore | Wis | Cal | Flo | Min | Ore | Wis | Cal | Flo | Min | Ore | Wis |
| Isolation Wastes | | X | | X | | | | | | | | | | X | | | | | | |
| Laboratory Wastes | X | | X | | | | | | | | | | | | | | | | | |
| Pathological Wastes | X | X | X | X | X | | | | | | 1 | | | X | | 2 | | | 2 | |
| Microbiological Wastes | | X | | | | | | | | | | | | | | | | | | |
| Sharps | X | X | X | X | X | | | | | | 1 | | | X | | | | | 3/4 | 3 |
| Blood, Blood Products | X | X | | X | | X | | | X | X | | | | X | | | | | | |
| Excretions & Secretions | X | X | | | | X | | | | X | | | | | | | | | | |
| Animal Carcasses & Body | X | | X | X | X | | | | | | 1 | | | | | | | | | |
| Contaminated Equipment | X | | | | | | | | | | | | | | | | | | | |
| Non-anatomical Wastes ie, gauze, dressing, tubing, etc. | X | X | | | | | | | | | | | | X | | | | | | |

1. Class I or II, landfill
2. Burial or cremation
3. Compaction
4. Grinding

- Oregon guidelines permit the disposal of isolation wastes, pathological wastes, sharps, blood and blood products, and contaminated solid wastes at land fills while California guidelines permit the disposal of pathological wastes, sharps and animal carcasses at Class I or II landfills only under the authority of a health officer.

A summary of recommended disposal options for biomedical wastes is given in Table A8.11.

# APPENDIX 8.3

## 8.3 EUROPEAN INITIATIVES

A review of European guidelines for biomedical waste management was limited to the United Kingdom's Health Services Advisory Committee's guidelines for clinical wastes (United Kingdom, 1982).

### Generator Sources To Which Guidelines Apply

- Medical, nursing, dental, veterinary, pharmaceutical and related facilities utilized for practice, investigation, treatment, care teaching or research.

### Categories of Biomedical Wastes

- 5 groups of clinical wastes are identified in the guidelines.

A summary of waste categories is given in Table A8.12.

### Packaging and Labelling of Biomedical Wastes

- Wastes are recommended to be segregated at the point of origin.
- Wastes from treatment areas should be placed directly into clinical waste storage bags or bins, lined with a plastic bag. Liner bags are to be removed at least daily or when three-quarter full, fastened with adhesive tape and placed inside a clinical storage bag.
- Clinical bags are colour coded depending upon the type of waste and the treatment or disposal method.
- Sharps are to be disposed of in impenetrable, leak-proof containers which when full are sealed and placed in a clinical bag for removal and disposal.
- No requirement for labelling waste containers or bags were noted.

### Storage of Biomedical Wastes

- Storage areas for clinical wastes should restrict access to unauthorized persons.
- Storage facilities should be in a separate area and should be of adequate size to allow for frequency of waste collection and allow bags of each colour to be kept separate.

### Transport of Biomedical Wastes

- On-site transport of clinical wastes should be in trolleys or carts that are leak-proof, impermeable and should facilitate ease of loading, unloading and securing of waste loads.
- Chutes, hoppers and storage chambers may also be used for transporting wastes on-site.
- Vehicles transporting wastes off-site for treatment or disposal should separate clinical wastes from other wastes, and should be constructed to prevent spillage.
- A contingency plan should be filed to manage accidental spillage of clinical wastes during transport.

# APPENDIX 8.3

## TABLE 8.A12
## THE UNITED KINGDOM HEALTH SERVICES ADVISORY COMMITTEE'S RECOMMENDED TREATMENT AND DISPOSAL FOR CLINICAL WASTES

| Waste Categories | Autoclave | Incinerate | Landfill | Sewage | Other Not Stated |
|---|---|---|---|---|---|
| Group A | | | | | |
| • haemodialysis wastes | X | X | | | |
| • treatment area wastes | | X | X | | |
| • human tissues, limbs, etc. | | X | | | |
| • infectious, laboratory, carcasses | | X | | | X |
| Group B | | | | | |
| • syringes, needles, broken glass other sharps | | X | | | |
| Group C | | | | | |
| • laboratory and postmortum wastes chemical pathology, microbiology histology and blood transfusions | | | | | X |
| Group D | | | | | |
| • pharmaceutical and chemical wastes | | X | | X | X |
| Group E | | | | | |
| • disposable bed-pan liners, urine containers incontinence pads, stoma bags | | X | | X | |
| • item contents | | | | | |

## Treatment of Biomedical Wastes

- Haemodialysis wastes may be autoclaved.
- Treatment methods for other waste categories were not addressed.

## Disposal of Biomedical Wastes

- Incineration is the recommended disposal method for most waste categories.
- Landfill disposal is permitted for wastes from treatment areas only if incineration is not available.
- Small quantities of pharmaceutical wastes may be discharged to sewer, while larger quantities should be returned to the hospital pharmacy for disposal.
- Waste organic solvents should be disposed of in accordance with Department of Environment regulations.

A summary of recommended treatment and disposal practices for clinical wastes is given in Table A8.12.

# APPENDIX 8.4

## 8.4 REVIEW OF GUIDELINES FOR ANTINEOPLASTIC WASTES

Concern for the safe handling, administration and disposal of antineoplastic drugs and their wastes have prompted numerous agencies to develop guidelines.

In Canada, guidelines for antineoplastics and cytotoxic pharmaceuticals have been developed by Ontario (Ontario Hospital Association, 1982), Manitoba (Manitoba Cancer Treatment and Research Foundation, 1984), Saskatchewan (Saskatchewan, 1985), the Canadian Society of Hospital Pharmacists (CSHP, 1981) and the Canadian Standards Association (CSA, 1988). The CSA's recommendations are based on guidelines recommended by the CSHP.

In the United States, guidelines for antineoplastics have been issued by the National Institute of Health (NIH) (Vaccari et al, 1984), American Society of Hospital Pharmacists (ASHP, 1985), Michigan Department of Public Health (Michigan, 1985) and the Occupational Safety and Health Administration (OSHA, 1986).

Management strategies listed below represent an overview of recommendations from these guides.

### Handling Antineoplastic Wastes

Recommended safety apparel includes:

a) long sleeve water-repellant disposable garments with a sealed front
b) disposable latex gloves
c) protective eyeware
d) respiratory protection eg., disposable dust or mist respiratory mask (not a surgical mask)

### Packaging of Antineoplastic Wastes

- Segregate from other waste streams
- Cytotoxic pharmaceuticals, associated contaminated materials, (ie. tubing, vials, containers) wastes from patients receiving antineoplastics, discarded gowns, gloves, eyeware, masks should be placed into designated cytotoxic waste containers.
- Cytotoxic waste containers include:
    - sealable plastic or wire-tie bags or 4 mil polyethylene or 2 mil polypropylene, colour coded and labelled cytotoxic or biohazard;
    - plastic lined rigid, puncture resistent, leak proof containers labelled cytotoxic or biohazard.
- All sharps should be packaged in puncture proof, hardshell containers designated for cytotoxics and taped closed. Containers should be labelled with cytotoxic hazard symbol.
- Some agencies recommend that all cytotoxic wastes, including sharps containers be double bagged in yellow or other designated colour-coded bags and bags securely tied and tagged with a colour-coded tag bearing the cytotoxic or biohazard symbol.

## Storage or Antineoplastic Wastes

- Access to storage should be restricted to authorized personnel.
- Storage areas should be posted with warning signs, a list of all drugs covered and a spill procedures policy.
- Warning labels should be applied to all containers, shelves and bins where antineoplastics are stored.

## Transport of Antineoplastic Wastes

- Transport of cytotoxic wastes within health care facilities should be in a manner which precludes breakage or leakage or contents. Recommendations include:
    a) proper packaging and labelling of wastes
    b) transport of packaged wastes in open or closed cart, pneumatic tubes should not be used

c) housekeeping personnel should wear gowns and latex gloves when handling wastes and waste containers

- Antineoplastic wastes transported for off-site treatment or disposal should be packaged to prevent spillage or leakage of contents. The Occupational Safety and Health Administration (1986) and American Society of Hospital Pharmacists (1983) recommend that antineoplastic wastes be packaged in drums lined with a 65 mil - polyethylene (or equivalent) liner for pickup and transport by licensed waste-disposal companies.

## Treatment and Disposal of Antineoplastic Wastes

- Where possible unreconsitituted or unopened vials, ampoules or bottles of antineoplastic pharmaceuticals should be returned to the manufacturers or distributing agents.
- Incineration at 1000°C is the disposal method of choice for antineoplastics, however, if incineration is not available other acceptable disposal methods include:
    a) disposal of small quantities of cytotoxic wastes in municipal landfills or sanitary sewer in accordance with Provincial, State and Municipal Regulations;
    b) chemical deactivation of some cytotoxic pharmaceuticals.

# APPENDIX 8.5

## 8.5 LABORATORY GUIDELINES FOR BIOHAZARDOUS MATERIALS

Documents from the World Health Organization (WHO, 1983), the National Institute for Occupational Safety and Health (NIOSH) (Flury, 1978) and the Medical Research Council of Canada were received. General management strategies for biohazardous materials were assessed for the following:

- containment levels, risk group levels, and biohazard classes
- laboratory access requirements
- packaging requirements
- decontamination and disinfection requirements
- disposal requirements

### Containment Levels

Containment levels (MRC), risk group levels (WHO) or biohazard classes (NIOSH) are used as indicators of the relative hazards posed by microorganisms being handled in the laboratory environment. As such, containment levels dictate the necessary laboratory design features, construction, containment equipment and personnel precautions that are required for the safe handling of microorganisms from within a given containment level.

Six levels of containment are outlined by the MRC, while most other agencies define four levels, some overlap exists between these standards. The relationship of containment levels from the Medical Research Council of Canada (MRC), World Health Organization (WHO), National Institute of Occupational Safety and Health (NIOSH), US National Institute of Health (NIH) and a report to the State of Education and Science of the United Kingdom (UK category) is given in Table A8.13.

The WHO categories for infective microorganism risk groups, serve as a typical example of the classification schemes utilized by other agencies in establishing containment levels. The classification scheme for infective microorganisms by risk groups used by the WHO is as follows:

**Risk Group I** (low individual and community risk). A microorganism that is unlikely to cause human disease or animal disease of veterinary importance.

**Risk Group II** (moderate individual risk, limited community risk). A pathogen that can cause human or animal disease but is unlikely to be a serious hazard to laboratory workers, the community, livestock, or the environment. Laboratory exposures may cause serious infection, but effective treatment and preventive measures are available and the risk of spreading is limited.

**Risk Group III** (high individual risk, low community risk). A pathogen that usually produces serious human disease but does not ordinarily spread from one infected individual to another.

**Risk Group IV** (high individual and community risk). A pathogen that usually produces serious human or animal disease and may be readily transmitted from one individual to another directly or indirectly. (WHO, 1983).

# APPENDIX 8.5

## TABLE A8.13

## COMPARISON BETWEEN THE PHYSICAL CONTAINMENT LEVELS OF MRC, WHO, NIOSH, NIH AND UK GUIDELINES

| MRC | WHO | NIOSH | NIH | UK |
|---|---|---|---|---|
| A | - | 1 | P1 | - |
| B | I | 2 | P2 | I |
| C | II | 2-3 | P2-P3 | II |
| D | II-III | 3-4 | P3-P4 | II-111 |
| E | III | 4 | P3-P4 | III |
| F | IV | 4 | P4 | I |

Table A8.14 relates risk groups to various categories of laboratories.

## Laboratory Access

- MRC recommend that access to all laboratories of containment level C to F be restricted to authorized persons; similar recommendations are applicable for NIOSH classes 3 and 4 laboratories and WHO levels III and IV.
- Access doors to laboratories should be posted with appropriate signs, such as the international biohazard symbol or with an infectious substance label.

## Packaging Requirements

- Infectious and diagnostic specimens should be packaged in three layers
  - a) primary water tight receptacle containing the specimen
  - b) a secondary water tight receptacle enclosing enough absorptive material to absorb all fluid in the case of leakage or breakage, and
  - c) a rigid outer package intended to protect the secondary package from physical damage and water.

  It is recommended that a copy of specimen data forms be securely taped to the outside of the secondary container (WHO, 1983),
- MRC recommends that agents requiring containment levels D to F be transported only if necessary (MRC, 1980).
- Infectious substances are regulated as a dangerous goods under the Federal Transportation of Dangers Good Act and Regulations and as such must be labelled with the international biohazard symbol and all shipments of more than 5Kg or 5L must be accompanied by a manifest (Transport Canada, 1980).

## Decontamination and Disinfection

- Autoclaving is the recommended procedure for decontamination (MRC, 1980; WHO, 1983).
- Other suitable decontamination measures include:
  - a) boiling for 30 minutes in water, preferably containing sodium bicarbonate, or
  - b) use of a pressure cooker at the highest attainable working pressure
- WHO (1983) discourages the use of dry heat and ultraviolet irradiation based on unpredictable variations.
- Facilities are recommended to have a written disinfection policy.
- Sodium hypochlorite is recommended for the disinfection of laboratory materials, MRC (1980) recommended that 0.2% to 0.5% detergent be added to improve effectiveness.
- WHO (1983) recommends the use of formaldehyde as a disinfectant alternative.

## Disposal

i) Sharps - should be placed in puncture resistant containers; when full containers should be placed in contaminated waste containers and incinerated, even if they are autoclaved first.

ii) Solids - reusable items, such as glassware should be autoclaved otherwise disposable items should be incinerated or autoclaved before disposal.

## APPENDIX 8.5

## TABLE A8.14

## RISK GROUPS IN RELATION TO CATEGORY OF LABORATORY

| Risk Group | Laboratory Classification | Examples of Laboratories |
|---|---|---|
| I<br>Low individual risk<br>and<br>low community risk | Basic | Basic teaching |
| II<br>Moderate individual risk<br>and<br>limited community risk | Basic<br>(with biosafety cabinets or other appropriate personal protective or physical containment devices when required) | Primary health serives,<br>primary level hospital;<br>doctors' offices;<br>diagnostic laboratories;<br>university teaching;<br>public health laboratories |
| III<br>High individual risk<br>and<br>low community risk | Containment | Special diagnostic laboratories |
| IV<br>High individual risk<br>and<br>high community risk | Maximum containment | Dangerous pathogens units |

(a) when larger volumes or high concentrations are used, or when techniques may involve aeroso other agents should be promoted to Risk Group III.
(b) Includes research laboratories at appropriate risk group level.

(World Health Organization, 1983)

iii) Liquids - some liquids, such as cultures, should be inactivated prior to disposal via the sewer disposal system (MRC, 1980). The WHO (1980) recommends that all cultures be autoclaved prior to being placed in containers for disposal.

iv) Animal carcasses - should be incinerated.

# APPENDIX 8.6

## 8.6 REFERENCES

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# APPENDIX 9.0

# REGULATORY AGENCY ADMINISTRATIVE ACTIVITIES

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# APPENDIX 9.1

## GVRD "DRAFT - AIR POLLUTION BYLAW NO. 603"

Domestic and commercial waste categories to be regulated under the proposed GVRD "Air Pollution Bylaw No. 603"

Definitions:

(g) "Domestic and Commercial Waste" includes wastes within classifications A, B and C of Table 3.1, CSA Standard Z103-1976, Incinerator Performance, a copy of which is annexed here to as Schedule "A"

### SCHEDULE A

### CLASSIFICATION OF WASTES

| TYPE | DESCRIPTION | EXAMPLE |
|---|---|---|
| A | Cellulosic solids, up to 15 per cent moisture (wet basis) | Dry paper<br>Cardboard boxes<br>Wooden pallets<br>Furniture<br>Photographic film |
| B | Cellulosic solids, 10 - 50 per cent moisture (wet basis) | Wet paper<br>Moist sawdust<br>Damp rags or clothing<br>Residential refuse<br>Bark |
| C | Cellulosic solids, over 40 per cent moisture (wet basis) | Fruits and vegetables<br>Garden trimmings<br>Kitchen wastes |

# APPENDIX 10.0

## REVIEW OF MAJOR REPORTS ON BIOMEDICAL WASTE

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# APPENDIX 10.1

## THE PRESENTMENT OF THE STATE GRAND JURY CONCERNING THE TREATMENT AND DISPOSAL OF HOSPITAL AND INFECTIOUS WASTES IN THE STATE OF NEW JERSEY: THE NEED FOR STATUTES AND REGULATIONS - 1987

In February 1987, the Grand Jury commenced its investigation into the handling, treatment and disposal of infectious waste generated by hospitals and other health care providers in the State of New Jersey, as well as in neighbouring States (insofar as their infectious wastes are transported or may otherwise reach New Jersey).

What prompted the need for the inquiry was a combination of:

(a) the complete absence of statutes and meaningful regulations in controlling the handling and disposal of infectious waste in New Jersey

(b) the importation and abandonment of infectious waste from other states (with more stringent regulations in those states)

(c) a number of incidents of substantial public reaction.

Health risks were not the only concern of the inquiry. The public's perception of the aesthetic considerations affecting the proper handling of infectious and hospital waste should also be considered. Society is becoming more sensitive to environmental concerns and certain handling and disposal practices could be considered repugnent to society's sensibilities.

### Scope of the Investigation:

This focused on:

(a) existing guidelines for handling and disposal of infectious wastes

(b) origins of infectious waste (facilities)

(c) definitions of infectious waste (i.e. threat to handlers, patients or the public at large)

(d) potential public health problems stemming from inappropriate handling and disposal of infectious waste

(e) methods of disposal, sterilization, treatment, transportation or risk amelioration which are technically and scientifically adequate and economically feasible.

The Grand Jury was concerned that incidents were required to demonstrate serious and substantial defects in a system that was thought to be properly controlled.

Additionally, the Grand Jury was most concerned that attempts had been commonplace to conceal the true nature of waste from hospitals arriving at landfill sites. The concern was extended to include the fact that it was impossible for landfill personnel to determine whether or not those materials had actually been treated or sterilized in the health care facility before disposal. The behaviour was found not to be covered by any current regulatory and statutory guidelines.

The Grand Jury received substantial information concerning the practices of several waste haulers purporting to be specialized in the business of infectious waste removal and disposal.

## History of Regulations and Present means of Disposal

Although infectious waste could be generated from a number of sources within and without the state of New Jersey, it was not then considered a separate identifiable waste category. It was lumped with household waste for the purposes of regulation.

Strict governmental control of waste disposal was found to be only a recent development in the United States of America (dating from approximately the late 1960's). Solid waste was grouped into a number of different categories by the New Jersey Department of Environmental Protection by assigning identification numbers. Rules were then applied to each waste-stream's characteristics, which covered the transportation and disposal appropriate to the type of waste. Prior to 1984, infectious waste was was identified as a special category but regulations pertaining to its disposal were never published.

In consultation with the New Jersey Department of Health, the New Jersey Department of Environmental Protection delisted infectious waste as a special category and to regard it as ordinary household waste based on the premises of:

(a) infectious waste was not perceived to pose a significant threat to the public - at least not one which would necessitate strict controls

(b) concern with the lack of commercial facilities to provide special treatment of infectious waste.

The process involved:

(a) a change in definition of infectious waste

(b) the generator was required to ensure that the Department of Health's guidelines had been complied with and to certify the fact to the waste hauler

(c) the collector of waste was required to obtain such a certification from the generator.

The process was seldom policed or enforced and was deficient in the fact that not all generators came under the jurisdiction of the Department of Health. The Department of Health, through its authority to accredit and license health care providers, established guidelines governing infectious waste treatment and disposal in its Hospital Licensure Manual (the guidelines occupied only a single page.

The guidelines required health care providers to incinerate solid waste from microbiology laboratories or to autoclave before disposal to landfill or transportation off-site; to autoclave liquid microbiological wastes prior to disposal in the sewer; to incinerate tissues (double bagging was an acceptable option for off-site disposal; to autoclave sharps prior to disposal; to autoclave or incinerate disposable tubes and plastics. The guidelines did not have the effect of enacted regulations or statutes.

A practical definition of infectious waste was considered by the Grand Jury to recognize certain waste streams as infections - i.e. requiring special precautions regardless of scientific proof. The Jury also noted that extensive study had taken place in the United States of America on potentially infectious waste-streams, which has resulted in a number of recognized national standards specifying which wastes should be considered infectious (Centre for Disease Control, Atlanta, Georgia; United States Environmental Protection Agency; etc.).

It is important to note that the more broadly infectious waste is defined, the greater the quantities of material are generated for disposal and the increased costs that are associated with its disposal.

The regulatory authority of the department of Health applied only while the waste was in the the health care facility, hence the necessity for for other regulatory authority from the Department of Environmental Protection.

Three levels of regulations were found to be required:

(a) to control intra-facility handling (generators)

(b) to control inter-facility transport (haulers)

(c) to control final disposal off-site (environment)

The Issue of Isolation Waste:

Isolation waste was considered to be that waste emanating from patients with certain highly contageous diseases. Evidence was obtained that pathogens can remain viable for quite some period of time with the potential of exposure risks to handlers throughout the life of the waste-stream. While the Grand Jury was given evidence to the fact that infectious waste was seldom, if ever, physically handled once it leaves the point of generation. The Jury was not convinced of the safety assurance of this evidence and concluded that the assurance was optimistic, sanguine and inaccurate.

Conclusions:

(a) In addition to the actual risks involved in the management of infectious waste, there are also valid aesthetic considerations and legitimate perceptions and concerns of the public at large. The latter considerations raise apprehensions and to be persuasive in and of themselves, apart from any scientifically ascertainable health risk.

(b) Unless there is confidence on the part of waste handlers, as well as the public at large, that their concerns are known and heeded, health care providers may soon face a serious waste disposal problem as waste disposal facilities are closed to them.

(c) Insofar as the regulation of infectious waste in New Jersey is perceived to be or is less stringent than those of the surrounding states, it is self evident that New Jersey could become a "magnet" for infectious waste.

(d) The mere publication of rules concerning the transportation and disposal of infectious waste is inadequate to address the problem. Lack of penal or civil penalties will not overcome the overwhelming temptation to improperly dispose of such wastes.

(e) Unlike health care workers in a hospital environment, waste handlers are provided with neither the training nor the tools routinely afforded hospital patients and personnel to protect against infection.

(f) There was no consistent method of identifying potentially harmful infectious waste once it left the hospital to enable handlers to take appropriate precautions.

(g) While infectious waste does not pose the same nature and quality of risk that is posed by toxic and hazardous wastes, allowing infectious waste to be treated as ordinary household garbage is inappropriate.

(h) The lack of any comprehensive and consistent regulation could eventually lead to a crisis of public confidence which will create difficulties in infectious waste management.

Recommendations

1. Comprehensive "cradle to grave" regulation (point of generation to the point of final disposal) is both appropriate and necessary to ensure that infectious waste is appropriately managed at all times.

2. A special medical waste manifest system is needed to:

    (a) deter operators from engaging in unscrupulous practices

    (b) clearly define health care providers' responsibilities

    (c) enable handlers, haulers and landfills and other points of disposal to take appropriate precautions and special care while handling infectious waste.

3. Special licensing of infectious waste handlers is necessary to ensure proper handling and disposal of infectious waste.

4. An inter-agency, inter-governmental approach is necessary to combat the problem of illegal disposal of infectious waste.

5. The Legislature should implement statutes providing appropriate civil and criminal sanctions for violation of this scheme.

6. The New Jersey Department of Environmental Protection should act to insure that health care providers are able to dispose of infectious waste in an economical and orderly fashion.

    All the available evidence conclusively demonstrates that properly and completely disinfected hospital waste poses no danger to those who come in contact with it. It can be properly landfilled or incinerated. Waste which is properly identified and certified should be accepted by landfills on the same basis as household garbage.

# APPENDIX 10.2

## FINAL REPORT OF THE OHIO INFECTIOUS WASTE AD HOC ADVISORY COMMITTEE - MARCH, 1987

In September 1986, the committee was formed to consider the potential health consequences regarding the disposal of infectious waste.

The committee addressed 4 issues:

(a) What types of medical waste are potentially infectious?

(b) What are the public health risks or implications in infectious waste handling and disposal?

(c) What are the hazards associated with the handling of infectious waste?

(d) Is there need for legislative action or control?

In addressing the first issue (a), the committee relied heavily on the published documents from the Centre for Disease Control (CDC), 1985, and the United States environmental Protection Agency (USEPA), 1986. The major difference between the two sets of recommendations was that the USEPA guidelines included communicable disease isolation wastes in the category of infectious waste, whereas the CDC recommendations suggested that this category be handled in accordance with hospital policy. The USEPA recommendations also included four categories that could be considered optional by the individual facilities (i.e. contaminated laboratory wastes, surgery and autopsy wastes, dialysis unit wastes, and contaminated equipment.

The second issue (b) was addressed and it was concluded that there were no published reports to indicate that personnel in the waste management industry in Ohio, or elsewhere, becoming infected or suffering from a disease as a result of exposure to disposed waste. Pathogens perceived to be of major concern to the lay community such as the Human Immunodeficiency Virus (AIDS) and Hepatitis B, will not survive for a significant period of time outside of the host. Therefore, they do not pose a health hazard to to those handling medical waste.

The committee members who conducted a small non-random survey of small medical waste generators (including private physician and dental offices) found that most had not developed any policy for the disposal of medical waste generated at their facilities. This was in contrast to the findings of hospital surveys within Ohio which demonstrated that over 75% of hospitals had written guidelines in place and that over 90% of the hospitals were accredited, in which the accreditation process examined medical waste handling and disposal.

The committee was of the opinion that even though the larger facilities generate a larger amount of waste, there is no plausible reason to expect that similar waste generated by a smaller facility would be any less infections than generated by the larger facility.

In addressing the third issue (c), it was brought to the attention of the committee that the Occupational Safety and Health Association had the power to develop standards for the protection of workers at landfills. Also, it was established that there were no good procedures in place for the reporting of injuries and follow-up to determine if disease developed.

Discussion concerning the fourth issue (d), concluded that there was no need for legislative action or control of infectious waste disposal for the purpose of protecting the public from the threat of contracting disease through landfilled infectious waste. The evidence revealed that such a public health hazard did not exist. Legislation was probably required to cover the situation where infectious waste was being received from other states and perhaps to have consistent legislation over the whole of the state of Ohio (but not for public health reasons).

The issue of the need for a manifest system was raised but consensus of opinion was divided.

Recommendations:

"Based on the evidence, the committee concluded that there was no need for further legislative action or control of infectious waste disposal for the purpose of protecting the public health".

1: The committee consensus was that the CDC guidelines for categories of infectious waste adequately defined infectious waste, i.e. microbiology laboratory waste, blood and blood products, pathology wastes and sharps items.

2. There is no evidence to indicate that worker exposure to medical wastes has resulted in disease transmission in Ohio, or elsewhere. One of the main reasons no health hazard exists is because many generators are already disposing of their infectious waste in accordance with the recommendations of the CDC or USEPA. Another contributing reason is that by the time the infectious waste gets to the disposer, even if not sterilized, the bacteria and viruses that contaminated the waste are either no longer viable or of such a low level that they are incapable of causing disease. Hence, the committee consensus was that regulations for the disposal of infectious medical waste, promulgated for the sole purpose of protecting the public health of Ohio citizens, was not deemed necessary.

3. Since the Occupational Safety and Health Association is responsible for developing standards for the protection of workers at waste management facilities, which are not government owned, it is the recommendation of the committee that standards be developed and that waste management companies not covered by OHSA regulations develop standards based upon these guidelines.

4. The committee recommended against legislative action or control of infectious waste handling and disposal if the intent in acting would be to protect against nonexistent public health hazard of this waste.

   The committee recognized that legislation may go forward and local regulations may be promulgated. The committee strongly suggested that the following recommendations be taken into consideration should such action be taken:

   (a) careful consideration should be given to the costs of further regulations since it is unlikely it will improve or protect the public health

(b) the categories designated by the CDC be adopted as the definition of infectious waste

(c) any regulations adopted in Ohio cover all generators of infectious waste, other than households

(d) the guidelines of the CDC regarding methods to render infectious waste non infectious be considered adequate.

The committee also recommend that chemical disinfection or sterilization be included as an adequate alternative for rendering all four (4) categories of medical waste designated by the CDC as potentially infectious medical waste non-infectious.

# APPENDIX 10.3

## AN EXAMINATION AND RISK EVALUATION OF INFECTIOUS WASTE IN KING COUNTY, WASHINGTON - MARCH, 1988

In 1985, the Puget Sound Council of Governments issued a report on solid waste in King County, which included a recommendation that infectious waste be better controlled by local regulation. Concurrently, the solid waste crisis and the AIDS epidemic increased the concerns of the public and solid waste workers regarding potential hazards associated with the disposal of infectious waste. The Health Department conducted a study of infectious waste disposal in King County in 1987 to assess current practices and their associated risks.

The policy that existed in King County in 1987 was that the Seattle-King County Health Department was responsible for enforcing the provisions of the King County Board of Health Rules and and Regulations relating to solid waste. The departments policy was one of enforcement in response to complaints rather than through a formal inspection program.

The study included a questionnaire and survey of medical and related facilities. Some results of the study are summarized as follows:

| | |
|---|---|
| Waste Generation | Average 10-15 pounds per patient day |
| Infectious Waste | 3% - 15% of total hospital waste |
| Established written Infectious Waste Management Plans | 96% of hospitals<br>83% of laboratories<br>14% of medical offices<br>0% of veterinary offices |
| Infectious Waste Definition | No uniform consensus<br>Responsibility placed at hospital level (Infection Control Committee)<br>100% of Hospitals & Labs had definitions<br>46% medical offices had definitions<br>25% veterinary offices had definitions |
| Contingency Plans for Infectious Waste | Waste Regulations - requirement for all medical facilities<br>54% of hospitals had one<br>50% of laboratories had one<br>5% medical offices had one<br>0% veterinary offices had one |

Definition of Infectious Waste:

It was noted that a specific definition had not been developed at the federal, state or local level. Variability in response was expected and observed.

## Segregation & Packaging:

For wastes defined as infectious by the medical facility and designated for special treatment prior to disposal.

92% Hospitals & 100% Laboratories
Waste segregated at point of generation
A wide variety of container types used

## Treatment of Infectious Waste:

| | |
|---|---|
| Steam Sterilization On-site: | 58% Hospitals<br>66% Laboratories<br>9% Medical Offices<br>25% Veterinary Offices |
| Incineration On-site | 50% Hospitals |
| Incineration Off-site | 46% Hospitals<br>66% Laboratories |
| Chemical Disinfection: | 50% Laboratories<br>50% Veterinary Offices<br>14% Medical Offices |

Though it is generally assumed that the process of steam sterilization is effectively eliminating the microorganisms associated with infectious waste, this may not always be the case. Factors affecting the effectiveness may include:

Types of waste
Volume and compactness
Type of container
Position within the autoclave
Presence or absence of water
Temperature and duration

## Incineration

The USEPA states that incinerators that are properly designed, maintained and operated and effective in killing organisms that are present in infectious waste. If the incinerator is not operating properly, viable pathogenic organisms can be released to the environment in the stack emissions, residue ash or waste water. The public health significance of this is neither known or proven.

Data from large incinerators shows the potential release of dioxins heavy metals and acid gases as air pollutants. Hospital incinerators can present similar problems to a much greater degree, especially since most of these smaller incinerators do not have effective combustion or emission controls and their emissions are poorly dispensed. Hospital incinerators can be particularly problematic relative to excessive chemical emissions due to the high plastic content of the waste.

Compaction: 65% Hospitals
0% All other medical facilities

Note: 31% Hospitals compact sharps
31% Hospitals compact liquids
All wastes that are commercially collected receive compaction by the collection vehicles, therefore all waste was ultimately compacted prior to disposal.

Infection Potential of Solid Waste:

Body substances such as faeces, airway secretions and wound drainage always contain potentially infectious organisms, and blood, urine and other moist body substances sometimes do as well. Therefore wastes from an average household may contain human excreta, blood, exudates or secretions from disposable diapers, blood contaminated tampons, sanitary napkins, contaminated facial tissue, condoms, bandages, home used syringes, other wastes from home nursing programs, each containing potentially infectious organisms.

Limited studies relating to hospital wastes have found that the microbial loads are no greater and may even be less than that found from general household wastes. Individuals who are infected with AIDS are living in their homes and spend very little time in hospitals.

This is supported by the CDC report - "There is no epidemiological evidence to suggest that most hospital waste is any more infective than residential waste. Moreover, there is no epidemiological evidence that hospital waste disposal practices have caused disease in the community".

The authors of the report concluded that the solid waste/disease relationship has not been proven by their extensive literature search. They noted that obtaining of proven evidence is difficult due to the complexities of solid waste composition, treatment, handling, storage and disposal and the intricate exposure pathways to human population.

The study included comments on the infection potential from groundwater associated with landfills and also on the various methods of waste collections from residents, commercial properties, and the method used to collect such wastes.

Transfer Stations:

These serve as an intermediate point for waste collection. Transfer stations collect both commercial and residential wastes and compact them into large transport vehicles for transport to landfills. Complaints have been raised regarding unsecured medical wastes in the transfer stations though there was no report of disease being caused to solid waste workers by these events.

Recommendations:

1. A specific regulation for defining, handling, storing, treating and disposing of potentially infectious medical waste be adopted by the King County Board of Health amending the existing regulation, and by the City of Seattle, which currently does not regulate infectious waste.

2. Education/safety programs be developed and implemented for solid waste workers to provide an understanding of actual (versus perceived) infection risks and methods to protect workers from potential infection hazards associated with infectious agents in solid waste.

3. Public awareness education program be developed and implemented for the safe handling and disposal of potentially infectious "home" wastes.

4. Further research be conducted to examine health risks posed by infectious agents in solid waste.

Comprehensive Draft Regulations were included in the Study and accompanied Recommendation 1.

Without going into any significant detail the Draft Regulations called for the following sections:

## Section 1 - Definitions

A. An INFECTIOUS WASTE MANAGEMENT PLAN (Written) incorporating an overall program for managing infectious waste including but not limited to:

Designation of Infectious Waste

Handling of Infectious Waste to include:

- Segregation
- Packaging
- Storage
- Transportation and handling
- Treatment techniques
- Monitoring of treatment methods

Contingency Planning

Staff/Housekeeping Training

Compliance with Infectious Waste Regulations

B. Infection Control Committees

C. General Medical Waste (non-infectious)

## Section 2 - Producers of Infectious Waste

A. Application without regard to quantity produced to any producer but not limited to the 17 types of facilities listed.

## Section 3 - Infectious Waste management Plan

Each facility to have a complete plan covering all aspects of waste handling and persons responsible; to complete and internal annual review and; the Plan to be available for inspection at the request of a Health Officer.

## Section 4 - Definition of Infectious Waste

Eight categories were listed.

## Section 5 - General medical Waste - Storage and Removal

Storage regulations (existing)
Removal - at least once per week
Disposal - at approved sites

## Section 6 - Storage and Containment of Infectious Waste

A. Conditions for storage
B. Segregation at point of origin
C. Containment of Infectious Wastes - Non-Sharps
D. Containment of Sharps
E. Storage Conditions for C.
F. Reusable Containers
  - process of cleansing/decontamination
  - concentration/contact times of chemicals to be approved by Health Officer.

G Trash Chutes - prohibited use for infectious waste
H. Time Limits before Treatment - Sharps and Non-Sharps (Infectious Wastes)
I. Compaction - prohibited for infectious wastes
J. Segregation - from General Medical Waste Streams prior to treatment

## Section 7 - Infectious Waste Treatment and Disposal

A. Methods of Treatment for Each Category Defined (included in the array of treatment methods is a clause "other method approved in writing by the Health Officer).

B. Standards for Steam Sterilization and Incineration

C. Contingency Planning - written plan to be approved in writing by Health Officer

## Section 8 - Transfer of Infectious Waste to Off-Site Treatment Facilities

A. Registered Haulers (>100 kg/mth clause)
B. Conditions for the container or vehicle compartment
C. Segregation of waste in Vehicle if more than one type hauled
D. Transport only to Approved Treatment Site
E. Decontamination of Vehicles
F. Identifcation of Vehicles (Name or Trademark of Hauler)

## Section 9 - Standards Applicable to Transporters of Infectious Waste

A. Registration of Person (>100 kg/mth clause) & Process of Registration
B. Frequency of Renewal of Registration - Annually
C. Duties of Compliance with Regulations - federal, state & local

## Section 10 - Requirements for Commercial Infectious Waste Treatment and Storage Facilities

A. Permits

B. Operational Plan (written)
   - Receiving
   - Unloading
   - Disinfecting reusable containers
   - Protective clothing
   - Quantification of the maximum of amount of waste per month

C. New Plan Approval if Maximum to be exceeded by 25% or more
D. Provisions for Non-Compliance

## Section 11 - Inspection

Authority of Health Officer to inspect at any reasonable time for compliance of all operational aspects of infectious waste handling, transporting and disposal.

# APPENDIX 10.4

## REPORT OF THE ONTARIO INTER-MINISTRY TASK FORCE ON BIOMEDICAL WASTE - A STRATEGY FOR THE MANAGEMENT OF BIOMEDICAL WASTE - APRIL, 1986

The Inter-ministry Task Force was formed in April 1984 to deal with a short term problem within the Province and the critical accumulation of waste stored in private diagnostic laboratories across the Province as a result of licensed waste haulers serving this industry being denied routine access to hospital incinerators. Part of the study included surveys of hospitals for waste handling practices and the operating condition of biomedical waste incinerators used in the hospitals in the Province.

It was recognized that a successful strategy for biomedical waste handling and disposal depended on the various agencies and parties understanding and accepting their defined roles.

It was commented that biomedical waste disposal had become more of an environmental problem with the advent of a higher volumes of dryer waste and larger volumes of plastic (with a high percentage of halogenated compounds) which when incinerated may produce environmentally undesirable emissions. The burning characteristics of these compounds produce heavy smoke and may discharge infectious particles into the environment. The older incinerators were not able to cope with these changes without modification. Ninety-six hospitals had on-site incinerators in 1985, of which approximately 30% had difficulties in controlling emissions.

Any incinerator installed more than 5 years ago was deemed to be unlikely to be meeting the current standards of the Ontario Ministry of Environment. Only 4% of the 137 incinerators had been built in the last 5 years. The observation would be tested when the mandatory annual reports were received and analysed.

Approximately 62% of the incinerators were deemed to probably need either an upgrade or replacement (the majority in the replacement category) at a cost of approximately $15 million.

Costing:

Some hospitals were either not using or partially using their incinerators and having their biomedical waste removed by commercial haulers. The waste was taken to incinerators in and out of the Province. The cost of such a means of disposal could cost up to $10,000 per month for large medical facilities.

From the survey, it was estimated that an average hospital of approximately 200 beds could expect to spend about $2,000 per month on the decontamination of their biomedical waste and additional costs for hauling the residue to a landfill site.

Likewise, large laboratories are incurring approximately $10,000 per month to have their waste (contaminated) hauled and disposed of out of the Province. The laboratories were using autoclaves for the decontamination of waste but the exercise was found to be uneconomical.

Prior to 1985 biomedical waste was not legally defined in Ontario. The guidelines for the handling, storage, collection, transportation and disposal of pathological and institutional wastes classified such wastes as "pathological" to conform with the scheme adopted in the Canadian Standards Association guidelines. "Biomedical Waste" replaced "Pathological Waste" in Regulation 309 of the Environmental Protection Act of Ontario.

The survey revealed that the amount of biomedical waste generated by hospitals averaged between 2.3 and 7.7 kg per patient day and of this 0.75 kg per special care patient required incineration.

## Effects of the Legislation

Manifesting of Biomedical waste for transportation:

Generators have to be registered with the Ministry of Environment.
Use of the Ontario Manifest is mandatory.
Federal Manifest for out of Province transportation & disposal.
Carriers - Certificate of Approval.
Receiving Sites (disposal) - Certificate of Approval.

The Ministry of Environment can track biomedical waste disposal from "cradle-to-grave" for any one consignment.

Impact on Health Care Industry:

Improved segregation of wastes.
Improved use of puncture proof containers - sharps.
Improved use of colour coding and rigid containers.
Increased applications for Certificates of Approval by haulers.
Increased discretion of haulers in collecting wastes.

Impact on Licensed Waste Carriers:

Refusal by Regional Landfill Operators to take unpackaged biomedical wastes, infectious wastes, pathological wastes or wastes offensive to the senses.
Appropriate identification on decontaminated biomedical wastes
Increased Certification of haulers
Prosecution for non compliance.

Impact on the Use of Existing Hospital Incinerators:

Exemption from Section 27 of the Environmental Protection Act More have come back into use.
Permission of neighbouring facilities to share incinerators - but restricted to incinerators on the outside wall of the facility or stand- alone to prevent cross contamination.
Encouraged use of own hauling vehicles - less onerous conformance to Certificate of Approval process which is required by Commercial Haulers.
Annual Reporting on Operational condition of existing incinerators - including source, nature, quantity of waste incinerated and a professional assessment of the extent of compliance with Regulation 309.

Sharing Existing Steam Autoclave to Decontaminate Waste:

Ontario hospitals are not generally equipped with sufficiently large autoclaves solely dedicated to the decontamination of non- anatomical infectious waste.

A dedicated autoclave should be installed or located away from clean areas - if on outside wall or stand-alone then can be shared between facilities

Centralized Waste Processing Facilities:

Should be considered as an alternative to upgrading existing incinerators.

Predicting Hospital Incinerator Capacity:

Minimum capacity based on:

Total biomedical waste 6 kg/patient day
Special Care waste 1 kg/special care patient day
Laboratory waste 0.2 kg/patient day

Alternative Decontamination Technology:

Mechanical hammermill/chemical device - grinds waste to a grit and disinfected chemically in one operation - in use in the United States of America

The report addresses the need for training and education off all workers coming into contact with biomedical wastes and for further research into alternative technologies for decontaminating and disposing of infectious wastes.

### Contingency Planning

This matter was addressed because of the potential for the closing of borders and thus backing up biomedical wastes within the Province. A number of options were presented, using existing facilities.

### Testing of Ontario Hospital Incinerators

Estimated to cost approximately $5,000 per incinerator to test emission control, residual ash, temperature control, etc. This testing was recommended to establish whether an incinerator should be upgraded or scrapped and replaced.

### Recommendations

1. As a matter of policy, the Government should promote the establishment of regionally centralized biomedical waste disposal facilities.

2. Short-term low cost actions by hospitals to upgrade deficient incinerators should be rapidly implemented wherever feasible.

3. Detailed combustion engineering analyses should be carried out on those hospital incinerators identified to be deficient.

4. The Ministry of Health set aside a special budget to assist hospitals in the upgrading of existing incinerators.

5. Before any funds are committed, a cost benefit analysis be carried out on the various options available and described in this report.

6. The Ministry of Health be consulted under the Public Hospitals Act for assistance in funding with respect to long-term implementation of the Provincial strategy for the management of biomedical waste.

7. Medical laboratory biomedical waste disposal needs should be included in the planning of centralized biomedical waste disposal facilities.

8. A working group of professionals having representation, as a minimum, from the Ministries of Health and Environment be appointed and funded to advise on priorities and assist in the implementation of the strategy for the management of biomedical waste.

9. All generators of biomedical waste review the legislation to ensure that they meet the requirements of Regulation 309 including registration and manifesting of the waste, and the use of approved carriers and disposal facilities.

10. Research initiative such as the testing of alternative technology and criteria development be supported by the Ministries of Health and Environment.

11. The Ministry of the Environment review Regulation 309 for the purpose of updating its definition of "pathological waste" and consider the inclusion of specific biomedical waste handling procedures into the Regulation.

12. Every biomedical waste generator and receiver prepare and have available a contingency plan for the disposal of biomedical waste in emergency situations when routine disposal arrangements are interrupted. This contingency plan should be filed with the Medical Officer of Health.

## APPENDIX 10.5

### STUDY ON THE FEASIBILITY OF ESTABLISHING A CENTRAL WASTE MANAGEMENT FACILITY FOR BIOMEDICAL WASTES FROM THE GREATER METRO TORONTO AREA - NOVEMBER, 1986

Amendments to the Environmental Protection Act of Ontario in 1985 made generators of biomedical waste responsible for ensuring that their waste was properly segregated, packaged, handled and disposed of, by means of licensed haulers, or in licensed incinerators. The generator was made liable for any spills or any improper disposal practices of the licensed haulers. The generator was responsible for the origination and control of an elaborate manifest system for the audit and control of waste handling.

While solutions were being found in 1986/87 to address the the immediate and significant problems associated with the disposal of infectious wastes in Ontario, longer term problems associated with changes in emission codes and "levels of burn" for incinerators provided the need for ongoing investigation and the arrival at solutions to deal with biomedical waste disposal through incineration.

The study included a survey of Ontario hospitals (totalling 17,000 beds - a figure which is approximately 80% of the total hospital beds in British Columbia) and established the following profile:

A.

| Type of Waste | Quantity per Bed-Day | Average Disposal Costs per lb | per Bed-Day |
|---|---|---|---|
| Human Anatomical | 0.10 lbs | 51 cents | 1.5 cents |
| Non-Anat. Infectious | 0.59 lbs | 47 cents | 25.1 cents |
| General Medical | 8.96 lbs | 3.5 cents | 15.1 cents |
| Kitchen | 1.90 lbs | 6.5 cents | 20.0 cents |
| Other | 0.50 lbs | 15.7 cents | 6.8 cents |
| Total Wastes | 12.1 lbs | | |

B. The survey result were comparable to earlier results for Ontario hospitals in terms of total wastes per bed-day (13 - 14 lbs per bed-day).

C. Biomedical wastes were not accepted at Metro Toronto's refuse transfer stations nor at their incinerators. Non pathological wastes were accepted at landfills provided they were trucked directly and identified for special handling.

D. The management options reviewed were:

Status quo
Incineration
Shredding/disinfection
Autoclaving
Combinations

The status quo was no longer acceptable

Incineration:

Volume reduction 90% Weight reduction 75%
Energy recovery potential
High capital cost
Public opinion
Stringent Environmental Legislation

Capital Cost for 15,000 tons capacity (annual)
$12 million
Net Cost $11 million (Steam sales)
Break even for collection, incineration & ash disposal, debt servicing, operations and maintenance, - 6 cents per lb (average cost of infectious waste at 22 cents per lb and general waste of 4 cents per lb).

For non anatomical infectious waste only:
Capital cost $4 million.
No steam sales
Break even 22.5 cents per lb

Shredding/disinfection:

Sodium Hypochlorite solution
Solid/liquid separation
Solid residue to landfill and liquid to sewerage
Cost for Non-anatomical infectious waste:
    Capital Cost - approx $2 million
    Break even - approx 22 cents per lb

Autoclaving:

Rated capacity of 100,000 lbs of waste per 24 hours
Cost for Non-anatomical in|fectious waste:
    Capital Cost - approx $2.3 million
    Break even - approx 20 cents per lb

The autoclaving costing was based on the experience of a California installation and Ontario operating costs. Likewise, the shredding/disinfection option was based on an Indiana installation and experience.

## Recommendations

1. The option for the development of a central incinerator to deal with general medical and non-anatomical infectious wastes not be supported because of costs.
2. Options of limited incineration (non-anatomical infectious waste), shredding/disinfection and autoclaving be supported and receive further investigation.
3. Once one of the above options has been selected, proceed with site location and specific engineering drawings.
4. The Ministries of Health and Environment and the Municipality of Metropolitan Toronto be approached to assist in financing further studies for this topic.
5. That Metro Works be approached to provide, either free of charge or at reasonable cost, land and/or buildings from current excess Metro properties to be used for the central facility.

6. The Ministry of Health be approached for a capital cost grant to offset the capital equipment purchased for the central facility.

# APPENDIX 10.6

## STATE OF THE ART REPORT ON THE MANAGEMENT OF BIOMEDICAL (TYPE A) WASTES IN CANADA - FEBRUARY, 1988

The management of Biomedical Wastes in Canada is a Provincial responsibility. The federal government has concerns about this issue is so far as for the mandates contained in:

Animal Disease and Protection Act
Fisheries Act
Transportation of Dangerous Goods Act

Biomedical (Type A) Wastes are reported to be classified as follows:

| | |
|---|---|
| Class 1 | Human anatomical waste (infectious and non-infectious) |
| Class 2 | Animal anatomical waste (infectious) |
| Class 3 | Non-anatomical waste |

- (a) waste from any source which is:-
    - infected/contaminated
    - a cytotoxic agent or contaminated with a cytotoxic agent
- (b) Laboratory wastes and contaminated equipment
- (c) Products of recombinant DNA and hybrid or mutant organisms, animal virus research and synthesis and animal cell research and production.

Based on existing inventory data , biomedical wastes account for less than one percent (1%) of the total hazardous wastes generated in Canada.

Based on surveys conducted in Manitoba (1984) and British Columbia (1980) the real shift in waste categories (physical) is reflected by:

| Type of Waste | Approximate Percentage Composition | |
|---|---|---|
| | 1984 | 1980 |
| Cellulose Solids | 50 | 45 |
| Plastics | 22 | 14 ** |
| Rubber | 2 | 1 |
| Glass/metal/ceramics/ash | 10 | 20** |
| Others (food/pathological) | 16 | 20 |

** Shows the increasing use of plastics over recent times - the 1984 survey shows that halogenated to non-halogenated plastics ratios were approximately 2:1.

The Management Practices for Biomedical Wastes were listed for:

Ontario
Alberta
Nova Scotia
Quebec
Manitoba
Saskatchewan
Newfoundland & Labrador
Prince Edward Island
New Brunswick

No reference was made about practices or the lack thereof in British Columbia.

The report covered the "Best Available Management Technologies" described in the literature but there was no available information to establish the extent to which each technology is used in Canada.

Storage - Primary - Point of Origin
Colour Coding
Double Bagging (outer =or> 1.25 mils) (inner =or> 2.0 mils)

Secondary - Waste Holding and Pre-disposal
Most Biomedical wastes go direct to pre- disposal by special collection (as necessary)
Non-infectious/previously sterilized are temp|orarily stored centrally and should conform to CSA guidelines

Transportation - Handling - no fully mechanized system of waste handling - improved techniques come from appropriate training and better safety equip|ment.

On-site transportation from primary to storage to holding areas and then to pre- disposal areas. The former is usually by carts and the latter can be handled by a number of technologies:

Manually
Gravity Chutes
Pneumatic Tube/Chute system
Self propelled carts
Conveyor devices

CSA recommends techniques for cart cleansing and disinfection.

Off-site transportation to disposal unit or for further treatment (can be to landfill, incinerator, transfer station or to central sterilising facility).

Vehicles need to be clean, insulated and refrigerated for Class 1 & 2 wastes; not for Class 3 wastes. CSA recommends daily cleaning procedures.

Treatment Technologies: Generally to render infectious wastes non- infectious - heat (steam & dry), chemical, irradiation

There are many guidelines for steam steril|ization. Dry heat (batch or continuous) used for large volume liquid wastes, solid wastes and equipment. Dry heat process takes longer, requires a higher temperature and is more costly.

Chemical: - will not destroy bacterial spores. It is particularly useful for liquid wastes. Acids, alkalies, aldehydes, amines, halogens, heavy metal salts, ketones, quaternary ammonium compounds, phenolic compounds and hydrogen peroxide are used. Sodium hypochlorite and formaldehyde are frequently used for infectious liquids.

Irradiation: - Ultraviolet, gamma ray and accelarated electron type irradiation have been used for the treatment of solid and liquid wastes. Ultraviolet has poor penetrability. Irradiation is expensive technology (actual and for safety requirements).

Reduction Recycling & Reuse:

Generally very limited for health care facilities
Energy recovery is the major benefit.

Disposal:

Environmentally acceptable manner

Incineration: - Existing pathological incinerators are generally outdated (volume and mix of wastes). There is high capital cost for new, replacement or upgrading. Sterility of the residue has been questioned.

Incineration remains the unanimous disposal method for CSA, USEPA and the World Health Organization from an environmental and safety point of view.

Technologies include:

| | |
|---|---|
| Multichamber | - inline |
| | - retort |
| Controlled Air | - starved |
| | - excess |

Controlled air is the most suitable for biomedical wastes

Emissions such as opacity, particulate, hydrogen chloride, dioxins & furans are now the subject of control standards.

| | | |
|---|---|---|
| Opacity: | - new | - Zero Opacity |
| | - old | - 20% Opacity |
| Particulates: | - new | - 0.75g/kg of solids burned |
| Hydrogen Chloride: | - new | - 100 ppm (dry basis)<br>Very expensive |
| Dioxins & Furans:- | | little known data<br>Interim guidelines suggest<br>45ng/cubic meter |

Stack Height:- Complex formula but important

Landfill:

Discussions concerning Biomedical Wastes are generally contradictory.

Finding landfill sites that satisfy all criteria of geological and hygrogeological stability, economic feasibility and public acceptance is becoming almost impossible.

The World Health Organization states that "general waste and properly treated infectious waste can safely be disposed of in a landfill, but special measures may be necessary for aesthetic reasons."

Grinding/Shredding/Pulping & Dewatering are other processes to treat Biomedical wastes prior to landfill.

Sewerage:

Acceptable if liquid wastes have been properly sterilized.

Grinders are technologically feasible but have some practical problems on a large scale - also, aerosol may be generated which could pose a health risk.

Guidelines for the proper management of Biomedical wastes were listed in the report for all Provinces and Territories.

British Columbia

The B.C. Ministry of Environment does not have specific guidelines pertaining to the management of biomedical wastes. CSA standards (Handling of Wastes Within Health Care Facilities - Z317.10 - M1981 or its revised equivalent) are referred to in answer to enquiries by generators.

Requests for information on the management of antineoplastics drugs are filled by sending copies of articles and guidelines from the technical literature and from other jurisdictions.

The same situation prevails with the Ministry of Health except that it has no means of statutory or regulatory control of biomedical wastes.

The remaining Provinces and Territories have little in the way of specific guidelines except for Ontario, which recently developed fairly elaborate guidelines and controls.

The Canadian Standards Association has developed guidelines for the handling of waste materials within health care facilities.

The Canadian Society of Hospital Pharmacists developed national guidelines for the disposal of hazardous pharmaceuticals in 1983. Only basic methods of disposal are outlined.

Environment Canada has in place air pollution guidelines applicable to incinerators installed in federally owned facilities. There are guidelines for existing units and new units.

The Medical Research Council of Canada published guidelines for the handling of recombinant DNA molecules and Animal Viruses and Cells and are to be implemented in every Medical Research Council funded facility whose research involves these molecules and cells. Six containment levels are defined and specific recommendations are made for the managing of wastes according to the level of containment required.

## Conclusions & Recommendations

### Conclusions:

1. Segregation:

   Complete segregation of hospital waste has often been judged by administrators as being non-practicable. Some hospitals use the universal precaution approach and avoid the need for segregation. Colour coding is not universally used nor is it uniform when used. The Canadian Standards Association has colour coding guidelines but these are not universally adopted by hospitals and other health care facilities. Colour coding does allow for appropriate warning to handlers.

2. Treatment:

   The most common is autoclaving but this has some limitations and operators should be aware of the different standards for different load types.

3. On-site transportation:

   Because of the requirement for proper handling by trained personnel, mechanical and automated systems are not practical. Appropriate carts and cleaning practices are adequate to meet the needs.

4. Off-site transportation:

   There is increased need for this service with the closing of hospital incinerators and the increased usage of disposable items in health care. The Transportation of Dangerous Goods Regulations (Federal Legislation) provides exemption for "low concentration hospital wastes" from any particular precaution while in transit. Only wastes covered by Section 7 are regulated.

   Only Ontario has in place a regulated system for off-site transportation which involves appropriate declarations concerning the nature of the waste, manifests, and licensed haulers.

5. Incineration:

   The major issue with on-site incineration of biomedical wastes is the capability of existing incinerators to properly remove particulates and hydrogen chloride before emissions leave the stack. The elevated cost for installing proper equipment (scrubbers) may force more institutions to share their incineration facilities.

   The cost of a controlled air incinerator is approximately 20% higher than for a multiple chamber incinerator but the former is more controllable for the variations found in biomedical wastes.

6. Landfill:

   Characterizations of hospital associated pathogens, disease causation, harmlessness of incineration residues (ash), landfill dynamics and their effects on pathogens, landfill selection and operation are among areas identified as requiring more research.

## Recommendations

1. A uniform definition for biomedical waste be developed and adopted by all Provinces.

   Note: Although the classification scheme from the Canadian Standards Association and the resultant definition from the Ontario Ministry of the Environment set a precedent in Canada, a definition of biomedical waste without any ambiguities has yet to be developed. Terms such as "may be contaminated" must be eliminated.

2. Environment Canada should take a leading role in the development of environmental guidelines or code of good practice.

3. A comprehensive assessment of the Academic and Industrial Research Laboratories, the Pharmaceutical Industry and the Food, Drug and Cosmetic Industries is recommended.

   Note: This is to complement the reasonable information already available for health care facilities.

4. The role of Environment Canada should be to promote the development of appropriate legislation with the other provinces and territories.

   Note: Only two (2) provinces have recognized biomedical wastes from health care and research facilities as requiring special management.

# APPENDIX 10.7

## SURVEY OF HOSPITAL WASTE IN ALBERTA HEALTH CARE INSTITUTIONS" - MARCH, 1985

A meeting of the Provincial Board of Health Subcommittee on Hospital Waste was convened in 1984 to develop legislation to handle hospital waste. The status of treatment and disposal, current waste disposal problems, waste categorization and methods of disposal were discussed by the Subcommittee.

A questionnaire was developed from the input of Alberta Hospitals and Medical Care, Alberta Social Services and Community Health, and Alberta Environment. The objectives of the survey were to determine current waste disposal practices, quantities of waste and various types, and the ultimate location of disposal of waste with/without treatment.

The ancillary objectives were to provide input to the new Public Health Act and accompanying regulations, assessment of adequacy of present disposal systems and for planning future facilities, and the development of an accurate picture of waste generation and disposal practices for hospital funding agencies.

The report devoted considerable time and explanation of the questionnaire development and handling, however, the following results were found to be of interest and relevance:

Questionnaire Returns:

100% hospitals >500 beds (7 questionnaires)
75% hospitals <500 beds (75% of 91 questionnaires)
35% Auxiliary Hospitals (35% of 22 questionnaires)
44% of Nursing Homes (44% of 38 questionnaires)
60% of other hospitals (60% of 3 questionnaires)

i.e. 66% of the total hospital beds in the Province
(16,968 beds out of total of 25,695 beds)

Waste Generation Rates:

Acute Care (<500 beds):

| | |
|---|---|
| Total Waste | 7.3 lbs per occupied bed per day |
| Guideline | 7.9 lbs per occupied bed per day |

Acute Care (>500 beds):

| | |
|---|---|
| Total Waste | 14.9 lbs per occupied bed per day |
| Guideline | 15.0 lbs per occupied bed per day |

Auxiliary Care:

| | |
|---|---|
| Total Waste | 4.1 lbs per occupied bed per day |
| Guideline | Not Available |

Nursing Homes:

| | |
|---|---|
| Total Waste | 2.8 lbs per occupied bed per day |
| Guideline | 3.1 lbs per occupied bed per day |

Average Waste Per Hospital Bed = 6.6 lbs/bed

The guidelines are those issued by Alberta Hospitals and Medical Care - the sources of which were not reported.

Total waste generation for the Province have been calculated as being approximately 143,000 lbs per day.

| | |
|---|---|
| Acute Hospitals <500 beds | 36,000 lbs |
| Acute Hospitals >500 beds | 67,400 lbs |
| Auxiliary Care Facilities | 13,600 lbs |
| Nursing Homes | 20,700 lbs |
| Other Hospitals | 5,600 lbs |

Plastic Wastes:

| | |
|---|---|
| Acute Care Hospitals >500 beds - | 2.4 lbs/Occup Bed/Day |
| Acute Care Hospitals <500 beds - | 0.7 lbs/Occup Bed/Day |
| Total Province | 22,100 lbs |

Hydrogen Chloride Emissions:

Total Province (potential) 3,100 lbs
50% from the larger hospitals (>500 beds)

Incineration Facilities:

| | |
|---|---|
| Acute Care Hospitals | 94% |
| Auxiliary Care Hospitals | 50% |
| Nursing Homes | 32% |

Note: Approximately 65% of the incinerators have an inside location

82% in excellent or good condition
18% in poor condition

50% were installed post 1980

Segregation of Waste:

Varied between 59% and 73% - the highest rate was in the category of Nursing Homes.

54% of institutions used colour coding

Infection Control Committees:

30% of returned questionnaires gave a positive result
28% of Acute Care Facilities gave positive answer.

Recommendations:

1. The initiation of a weighing program at a number of the major hospitals would provide improved values for estimating waste generation and should provide a reasonable range to the values expected.

   Comment: It is difficult to understand this comment given the closeness of the results to the guidelines. Perhaps it was aimed at reducing the wide range of results found (vs averages for the Province).

2. Further investigation into quantifying plastic wastes and, therefore, hydrogen chloride emission from incineration.

3. A further review of the questionnaires to establish better data or interpretation on waste segregation.

4. Investigation of incinerators to determine if they should be replaced and over what time-frame.

5. Assessment of data on a regional basis for contingency planning (for incineration failures).

6. Re-examination of the questionnaire to establish a better interpretation on training programs.

7. Comparison to other Provincial data on waste generation weights to check the validity of the data from the questionnaire source.

# APPENDIX 10.8

## HOSPITAL INCINERATION STUDY - ALBERTA - MARCH, 1984

Alberta Environment was concerned about the inability of almost all major hospitals in the Province of Alberta to meet the hydrogen chloride (HCl) emission guideline applied to incinerators processing hospital wastes. The generation of HCl results from the combustion of polyvinyl chloride (PVC) plastic wastes.

Only 2 of the major hospitals of the Province in 1983 met the guideline; the others did not meet or were not expected to meet the guideline.

The objectives of the study:

determination of how HCl may be eliminated from incinerator exhaust gases

determination of how the PVC content of incinerated wastes might be reduced

determination of the effects of HCl emissions on health and vegetation, and corrosion effects.

The scope of the study was to obtain background information to provide a suitable context for the the development of alternative solutions to the HCl emission concerns by:

determination of the relationship of the quantity of PVC in hospital wastes to HCl emissions

determination of the effects of HCl - based on literature reviews

assessment of the development and rationale for the present Alberta Environment HCl emission guideline, and comparison with the Canadian Federal guideline, selected guidelines in other Provinces and the United States of America.

The following specific solutions were addressed:

specific sorting programs to eliminate PVC from the waste stream

purchasing policies to substitute other plastics for PVC

development of a central incineration facility with all required emission controls

installation of gas scrubbers to eliminate HCl

modification to the HCl guideline

land disposal of contaminated wastes

Background Information:

PVC is expected to increase in hospital wastes unless there are significant changes in market forces to replace it by polypropylene. Heat resistance is an important consideration for hospitals because of sterilization requirements.

Approximately 8% of wastes incinerated by hospitals is PVC and approximately 60% of the chlorine is emitted as HCl and the other 40% is retained in the ash.

Calculations have shown that 0.25% PVC in the total wastes to be incinerated will result in approximately 100 ppm HCl in the emissions from the incinerator stack. Therefore, the incineration of hospital wastes containing PVC will result in emission levels in excess of the Alberta Environment Guideline value of 100 ppm.

Health Effects:

According to United States data (as of 1976), there have been no reports of carcinogenic effects of exposure by humans to gaseous HCl.

The safe working level adopted by Alberta Workers' Health, Safety and Compensation, is 5 ppm for 8 hours per day (40 hours per week). This value is approximately 100 tomes the Alberta Environment guideline value of 0.06 ppm for ambient levels. Corrosion Effects:

Examination of the literature showed no publications relating to atmospheric corrosion effects of HCl - particularly in the range (and up to 10 times the range) of HCl emissions in the guideline.

Vegetation Effects:

Leaf damage occurs at ambient concentrations 50 times the Alberta Guideline of 0.06 ppm.

Although hydrogen chloride is an acid gas, the emission rates are many orders of magnitude less than those oxides of nitrogen and sulphur, and HCl need not be considered within the context of acid rain concerns.

Regulations Controlling Emissions:

"Guideline for Design and Operation of Refuse Incinerators in Alberta" - February 1983 - Section 5.2(3)(a)

No person should operate an incinerator from which the contaminants discharged into the atmosphere contain HCl in excess of 100 ppm on a dry basis and corrected to 50% excess air. (based on National Emission Guidelines for Packaged Incinerators)

HCl in the ambient air should not exceed 0.06 ppmv as a half hour average concentration because of the HCl emissions. (based on Ontario Guidelines)

NOTE: A most interesting point made in the report is that there does not appear to be substantive research evidence to justify the limit. An extensive literature search was performed.

Ontario:

Maximum concentration at the point of impingement is 100 ug of HCl per cubic meter of air (half hour average of 0.06 ppmv). The limit was based on the potential corrosion effect of HCl, however, there appears to be no specific studies carried out on atmospheric corrosion by emissions of HCl.

British Columbia:

Municipal waste discharges must not exceed the most restrictive objectives for the emission of HCl as follows:

| | |
|---|---|
| Level A | 50 ppm |
| Level C | 150 ppm |
| Average (Level B) | 100 ppm |

Existing incinerators are expected to meet the average level of 100 ppm, and most new installations are expected to meet Level A. The intent is to upgrade existing installations to Level A. There appears to be no concern about emissions from hospital incinerators in British Columbia. Although there are some limits on the emission of particulates, there are no limits set for HCl.

Canada:

The emission limits set in the guidelines (as above) are only for new installations - no limits have been published for existing installations.

Canadian Standard Association:

Z103-1976 Incinerator Performance: the emission rate of HCl shall not exceed 3.0 lbs of HCL per ton of waste charged. This applies to all incinerators.

In contrast, the emission limit for particulates depends on incinerator capacity.

United States Environment Protection Agency (USEPA):

1981 - "An incinerator burning hazardous wastes and producing stack emissions in excess of 1.8 kg/hour must control HCl emissions to 1.8 kg/hour (or approximately 100 ppm)".

Most of the States have their own control programs - therefore, the Federal body has not implemented this regulation.

The State of New Jersey has implemented a guideline of 50 ppm for incinerators of capacities >800 lbs/hour (including hospital incinerators).

### Conceptual Alternative Solutions:

The issues and concerns associated with the various solutions are related to the separation of contaminated and uncontaminated ward wastes and any special handling and treatment requirements prior to disposal.

Sorting Programs:

Pathological, contaminated and uncontaminated - three broad categories. Pathological is regarded as contaminated, also, the report regards these as being required to be incinerated and, therefore, discusses them no further.

The following conclusions were reached following a survey (visit) of 15 hospitals:

- all hospitals sort pathological waste
- most hospitals sort contaminated wastes (sticker or colour coded bags)
- only a few hospitals sort non-incinerable material
- most hospitals send regular wastes to landfill (open containers or by using compactors)
- all hospitals segregate sharps - incinerate them, or sterilize them and dispose of them in landfills

Feasibility of PVC Segregation:

It is difficult (even for trained personnel) to separate PVC plastics and other plastics (polyethylene and polypropylene).

The practice was considered not to be feasible.

Incremental Costs:

A mixed reaction was obtained from the hospitals on the incremental costs of sorting.

Other Considerations:

Once contaminated wastes are sorted and properly identified, the sorting program should ensure that the wastes are directed to the correct location for further treatment and/or disposal. A sorting program is only effective if endorsed by the administration and there is appropriate training of staff. There are concerns relating to increased costs associated with such a program.

Adequate segregation of contaminated wastes forms a basis for effective contingency planning for disposal.

Purchasing Policies:

Regarding the use of alternative plastics to PVC:

- there are significant increases in cost (up to 10 times) for alternative disposable plastics and suppliers are limited
- almost a complete change-over to polypropylene would be required to reduce HCl emissions to below the guideline limit
- a complete re-orientation of the North American market for hospital plastic disposables to polyethylene would be required for this to be a viable option.

Central Incineration Facility:

An alternative is to develop central incineration facilities. For a facility to cope with 60,000 lbs per day would have capital costs (1984 Dollars) of approximately $2.6 million and operating costs of approximately $0.72 million annually (including transport costs).

Operators must be trained in the knowledge and safe handling of the contaminated waste. Also, adequate procedures would need to be developed for collecting, handling and transporting the wastes.

Scrubbers:

To upgrade all incinerators to meet the guidelines - at the 15 hospitals would total approximately $7.0 million (1984 Dollars).

Scrubber operating costs would add between $1.0 and $4.0 million.

Modification of the Guideline Limit:

Based on the information obtained by the report writers, it is not proven that an emission limit of 100 ppm HCl from hospital incinerator stacks is required to protect the envir[illegible]t in its broadest sense.

Land Disposal of Contaminated Wastes:

Contaminated wastes should be disposed of in areas separate from the active working face. Risk of accidental or intentional exposure by site personnel and the public may be eliminated using a pit method disposal. In addition, the risk of transmission of pathogens by vectors may be controlled by proper management and covering of the disposal area.

The costs are modest in comparison to incineration.

The risks associated with the spread of disease need to be addressed in addition to procedures for safe handling and disposal being addressed.

Recommendations:

1. The present Alberta Environment emission guideline of 100 ppm in hospital incinerator stacks should be recinded and the basis of the guideline reviewed.

   An ambient monitoring and testing program should be set up and carried out through a joint hospitals/ Alberta Environment Task Force.

   The report provided the objectives and outlined the segments of such a monitoring program.

2. Existing hospital incinerators should not incorporate a water scrubber to remove HCl, and heat recovery should only be incorporated if it can be proven to provide economic benefit to the hospital.

   New incinerators should include provision for the addition of a water scrubber at a later date in the event that it is required because of proven environmental effects of HCl emissions.

3. The feasibility of land disposal of contaminated wastes should be investigated further, taking into account present and anticipated future regulations regarding transportation and disposal of contaminated hospital wastes. A characterization should be made of contaminated wastes and the results used:

- to develop safe handling and disposal procedures
- standards for design and construction of contaminated waste disposal areas

Areas separate from disposal areas for municipal wastes are recommended.

A program should be developed to determine how the land disposal option can best fit the requirements of contingency plans applicable to the disposal of contaminated hospital wastes.

4. Contingency procedures should be developed in the event that the current method for disposal of contaminated wastes generated by each hospital is not possible for whatever reason.

The following alternatives should be considered:

refrigerated storage at hospital on temporary basis
secure transportation to other hospital facilities
disposal in sanitary landfill

Contingency planning must apply to all hospitals.

# APPENDIX 10.9

## HAZARDOUS WASTE MANAGEMENT - AIR POLLUTION EMISSIONS FROM THE INCINERATION OF HOSPITAL WASTES - THE ALBERTA EXPERIENCE - 1987

Hospital incineration wastes contain between 20% and 30% plastics compared to municipal waste (3% to 7%).

Virtually none of the hospitals were following the guidelines for emission control of HCl.

Some hospitals could comply if they were operated properly - i.e. under optimal conditions.

Incinerators were tested for particulate matter and HCl.

Approximately 30% of the tested facilities had HCl levels within the guidelines - compliance was due to either scrubbers, remoteness of location or pre-incineration segregation of wastes.

In November 1983 Alberta Environment and the Department of Hospitals and Medical Care embarked upon a program to bring all offending hospital incinerators into compliance with the standards. None of the non-complying incinerators were to be shut down during this program.

In July 1984, a tentative compliance schedule for hospital incinerators was in place. Also, there was discussion concerning the conditions under which hospitals could use sanitary landfills.

In November 1984 the above study (Report 7) was commissioned.

In February 1986 Alberta Hospitals and medical Care notified the major hospitals of the Province that Alberta Environment had agreed to issue a conditional license to operate hospital incinerators on the understanding that their incinerators must meet the requirements of the Clean Air Act by the date shown on the compliance schedule between 1986 and 1989.

# APPENDIX 10.10

## 10.10 REFERENCES

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# APPENDIX 11.0

## GENERAL DISCUSSION

PAGE

APPENDIX 11.1 SPECIAL BIOMEDICAL WASTES 1

# APPENDIX 11.1

## SPECIAL BIOMEDICAL WASTES

The following seven types and sources of biomedical wastes from humans and animals are or are expected to be sufficiently noxious or infectious that they should be handled in a special manner.

1 ) isolation wastes - includes, for example, wastes from patients placed in isolation for reasons other than protection or reverse isolation, as laid out in the CDC guidelines for isolation precautions.

2 ) waste cultures and stocks of infectious agents and associated biologicals - includes, for example, specimens from medical and pathology laboratories; cultures and stocks of infectious agents from clinical, research, and industrial laboratories; wastes from the production of biologicals; disposable culture dishes, and devices used to transfer, inoculate, and mix cultures; and discarded live and attenuated vaccines.

3 ) waste human blood and blood products - includes, for example, waste blood, serum, plasma and blood products.

4 ) wastes from surgeries and autopsies performed on patients and animals - includes, for example, tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy.

5 ) wastes from patients and animals known to be infected by blood-borne diseases - includes, for example, equipment from surgery, autopsy, laboratories, dialysis units, and other material contaminated from care of patients with diseases such as AIDs and hepatitis B.

6 ) waste sharps - includes, for example, broken glass, hypodermic needles, and other sharp wastes, whether infectious or not.

7 ) waste contaminated animal carcasses, body parts, and bedding - includes, for example, animal carcasses, body parts and bedding of animals intentionally exposed to infectious organisms in research, in the production of biologicals or the in vivo testing of pharmaceuticals.

# APPENDIX 12.0

## BIOMEDICAL MANAGEMENT STRATEGIES AND RECOMMENDATIONS

PAGE

APPENDIX 12.1 GENERAL BIOMEDICAL WASTE DEFINITIONS 1

# APPENDIX 12.1

## GENERAL BIOMEDICAL WASTE DEFINITIONS

Biomedical wastes means those discarded materials from humans or animals which, due to their nature and source, categorized below, may require specific treatment before disposal.

Biological wastes means solid and liquid wastes from human metabolic functions including feces, urine, vomitus, dialysis byproducts, and the like.

Infectious means being contaminated or suspected of being contaminated with the causative agents, or their toxic products, of a communicable disease, and capable of transmitting such disease to susceptible individuals or animals.

Special biomedical waste means any waste falling under the following seven biomedical waste sources and types:

1 ) isolation wastes - includes, for example, wastes from patients placed in isolation for reasons other than protection or reverse isolation, as laid out in the CDC guidelines for isolation precautions.

2 ) waste cultures and stocks of infectious agents and associated biologicals - includes, for example, specimens from medical and pathology laboratories; cultures and stocks of infectious agents from clinical, research, and industrial laboratories; wastes from the production of biologicals; disposable culture dishes, and devices used to transfer, inoculate, and mix cultures; and discarded live and attenuated vaccines.

3 ) waste human blood and blood products - includes, for example, waste blood, serum, plasma and blood products.

4 ) wastes from surgeries and autopsies performed on patients and animals - includes, for example, tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy.

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6 ) waste sharps - includes, for example, broken glass, hypodermic needles, and other sharp wastes, whether infectious or not.

7 ) waste contaminated animal carcasses, body parts, and bedding - includes, for example, animal carcasses, body parts and bedding of animals intentionally exposed to infectious organisms in research, in the production of biologicals or the in vivo testing of pharmaceuticals.

## Biomedical Waste Categories[1]

1. Solid human anatomical wastes, including any body part or tissue except extracted teeth, hair, nail clippings, and the like, but excluding biological wastes.

2. Liquid human anatomical wastes such as blood products, secretions, and similar body fluids, but excluding biological wastes.

3. Infectious animal solid and liquid wastes, including animal carcasses, body parts, body fluids, bedding materials, and associated biological wastes.

4. Infectious biological wastes.

5. Infectious nonanatomical wastes directly associated with patient care such as bandages, gowns, masks, gloves, tubing, and similar equipment.

6. Waste sharps including hypodermic needles, syringes, scalpel blades, pasteur pipettes, and broken glass.

7. Infectious microbiological wastes including serums, vaccines, cultures, and stock used in clinical, research and industrial applications, and their associated fomites.

8. Chemical and pharmaceutical wastes including antineoplastics and associated fomites.

9. Supplementary biomedical waste categories include:

    - noninfectious animal anatomical waste
    - pharmaceutical contaminated animal anatomical waste
    - equipment and materials contaminated with chemical and pharmaceutical waste.

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[1] A number of the categories may be further broken into solid and liquid subcategories.